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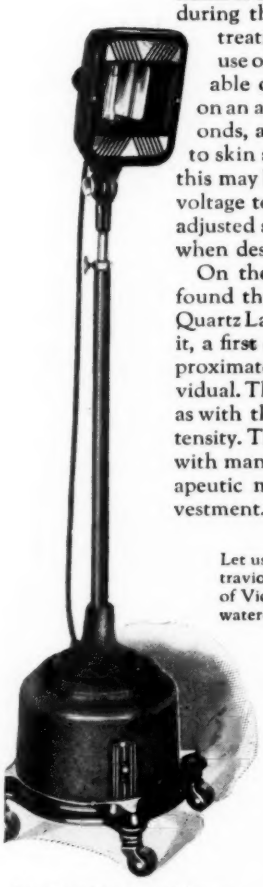

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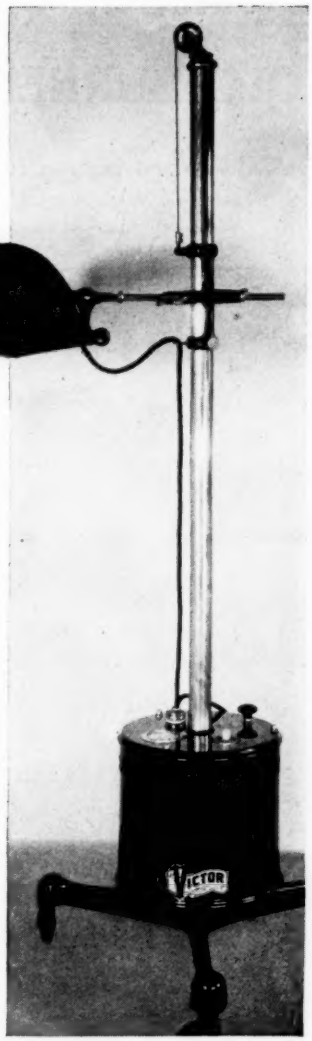

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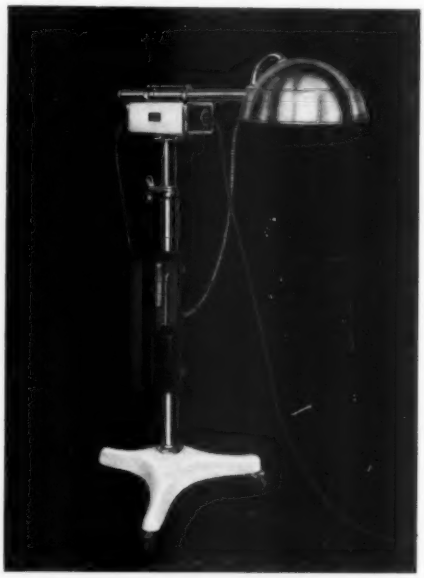

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INFLUENCE OF ULTRAVIOLET RAYS ON PHARMACOLOGICAL POTENCY OF DIGITALIS * **

DAVID I. MACHT

BALTIMORE, MD.

Introductory

Digitalis is the most important heart drug at the disposal of the physician. To insure a successful therapeutic effect from its use, however, it is absolutely necessary that an adequate dose of a reliable preparation be administered. Doses which are too small will not produce a beneficial effect, while excessive doses will induce toxic symptoms. For this reason all preparations of digitalis for medicinal purposes must be carefully assayed. This is done by biological methods inasmuch as there is no way of evaluating the potency of digitalis by chemical or physical tests. It is a matter of common knowledge to physicians and pharmacists that all preparations of this drug, even the alcoholic extracts and tinctures, undergo deterioration with time. The reason for this instability is still a matter of conjecture, and all the factors concerned in producing changes in the potency of digitalis preparations have not yet been discovered. The active principles of digitalis leaf, being for the most part glucosides, are subject to decomposition, especially in the presence of bacteria, moulds or acids, according to some investigators.[1] This may be true of the aqueous infusion of digitalis leaf, but bacterial or mould action certainly cannot play much of a rolê in the case of alcoholic extracts and tinctures. According to Bourquelet[2] and Choay,[3] enzymes have something to do with such deterioration. This, however, has also been disputed inasmuch as decomposition may take place even in strong alcohol and after heating digitalis preparations.

Light undoubtedly affects the potency of digitalis, especially of its liquid preparations; and it has been generally supposed that ultraviolet rays play a rolê in this connection. Yet there is no unanimous agreement among pharmacists and pharmacologists as to the extent of deterioration produced by such rays. Some writers have maintained that digitalis preparations undergo great deterioration,[4] [5] [6] [7] while others attach little importance to the whole matter.[8] [9] [10] [11]

In the present investigation an attempt has been made to gain a clearer knowledge in regard to the influence of ultraviolet rays on the keeping qualities and potency of tincture of digitalis.

Methods of Irradiation

Tincture of digitalis was employed exclusively in the present investigation, as this is the most important liquid preparation of digitalis leaf and is the preparation commonly prescribed by physicians. According to the United States Pharmacopoeia, the tincture is an extract of powdered digitalis leaf made by extracting one hundred grams of the powder with sufficient alcohol (70 per cent) to make one thousand cubic centimeters of solution. In the present research the original stock of any given tincture examined was kept in the ice chest and in the dark; and small samples of such digitalis were taken, whenever required, and irradiated in various ways. After irradiation, the potency of the specimens was compared with that of the original stock tincture.

The Alpine sun mercury vapor quartz lamp and the water-cooled mercury vapor Kromayer lamp were employed as the sources of ultraviolet rays. Samples of tincture were placed in quartz test tubes or other containers and exposed to the ultraviolet rays at various distances from the source. As a rule, such tinctures were irradiated in transparent quartz test tubes, 1 to 1.5 mm. in diameter. For comparative purposes, other samples of the same tincture were often irradiated simultaneously

* Presented before the Optical Society of America at Rochester, N. Y., October 22, 1931.

** From the Pharmacological Research Laboratory, Hynson, Westcott & Dunning, Inc., Baltimore, Maryland.

in test tubes of ordinary glass and of pyrex, respectively, in order to ascertain the effects, if any, of the very long ultraviolet rays and visible rays of light. Tinctures were irradiated not only with the direct rays of the Kromayer lamp but also with rays passing through such filters as the nickel oxide, or Wood's filter, and the chlorine-bromine gas filter.

In addition to experiments with ultraviolet rays, further studies were also made by exposing tinctures to x-rays, to radium and to radium emanations. In this connection, the author is indebted to Dr. Fred West, of the Howard A. Kelly Sanatorium, Baltimore, who kindly furnished the necessary apparatus and material for such experiments. The x-ray irradiations were made with a hard tube. The tincture of digitalis was exposed for ten minutes to the rays emitted from such a tube after they had first passed through a layer of 1 mm. of copper and 1 mm. of aluminum. In case of radium, a given sample of digitalis tincture in a glass tube was placed next to a quantity of radium inclosed in a copper container. When studying the effect of radium emanations, glass pearls containing them were crushed under the surface of a given tincture of digitalis; and the glass container was immediately corked with a rubber stopper.

Methods of Assay

Three methods of assay were employed in the various experiments. In some cases the official United States Pharmacopoeia one-hour frog method was employed.[12] This consists of injecting into a lymph sac of a frog a standard tincture of digitalis and determining the dose required to produce an arrest of the heart in systole one hour after injection. The amount of alcohol in such experiments is first reduced by evaporation and compensated by adding salt solution. A standard normal tincture of digitalis should produce standstill of the heart in doses of 0.006 c.c. per gram of frog.

For comparative work, however, the author preferred the more reliable cat method of assay introduced by Hatcher and Brodie,[13] and the phytopharmacological method of Macht and Krantz.[14] In the cat method, the animal is kept under light ether anesthesia and at regular intervals a dilution of 1:10 of a given tincture is injected into the femoral vein. The injections are continued until the heart is brought to a standstill and the respiratory center is still active for a short time after the heart has stopped. The quantity of the solution, per kilo weight, required to kill the animal is then ascertained. A standard normal digitalis should kill a cat in this manner when 1 c.c. of the tincture, or 10 c.c. of the 1:10 dilution, per kilo weight of the animal, has been injected.

In addition to the *zoopharmacological* frog and cat methods described above, the *phytopharmacological* test, first introduced by the author,[15] has been used very extensively in the present investigation. In this method living seedlings of *Lupinus albus,* properly germinated in a suitable medium, as described by the author in various publications, are immersed in a normal plant-physiological solution, on the one hand, and in 0.5 or 1.0 per cent solution of tincture of digitalis in a similar plant-physiological saline, on the other hand. From eight to ten seedlings are employed for each solution used, and observations are made on the growth of the single elongated, well defined roots, in the dark at a temperature of 21°C. This phytopharmacological method is especially useful for such comparative experiments as were performed in the present research because it admits of the examination of a large number of samples of any given drug on many living test objects, the investigations being carried on simultaneously under the same conditions of temperature, light or darkness, weather, etc. To do this, a series of rows of hard-glass tubes are set in upright position on a specially constructed board. In the first row eight or ten seedlings are suspended in normal physiological or Shive's solution,[16] and in each of the other rows of test tubes, similar seedlings from the same crop of plants are suspended in various solutions of digitalis tinctures in physiological saline. The original length of the roots of all the seedlings is carefully measured with a millimeter rule. The whole outfit is then placed in the dark in a suitable incubator and kept at a temperature of from 21°C. to 22°C.; and after twenty-four hours the increment of growth in each seedling is measured. The

inhibition of growth of the Lupinus roots produced by the various digitalis tinctures is then determined by comparison of the length of seedlings in the solutions under investigation with that of the controls in physiological saline, and expressed in terms of per cent, to which the name *phytotoxic index* has been applied. The phytopharmacological method is superior to the zoöpharmacological tests described above in that it admits of the use of a large number of individual test objects so that the average means of the readings obtained furnishes very reliable data.

Results

The results obtained with ultraviolet irradiation of tincture of digitalis by mercury vapor lamps may be described as follows: Exposure of the tincture in quartz containers to the rays produces a deterioration or weakening of the potency of digitalis, as tested on both animals and plants. Such a deterioration can usually be noticed even after a very short exposure. The delicate phytopharmacological method reveals that even a five- or ten-minute exposure of a tincture in a quartz container, placed against the window of a Kromayer lamp, will produce a definite weakening in potency of the digitalis. When such a tincture is irradiated in an ordinary glass test tube, however, practically no deterioration occurs; and exposure of the digitalis in a pyrex glass tube produces only a slight weakening of the drug, thus indicating that the longer ultraviolet rays have but little effect. When a digitalis tincture is exposed to the rays of a Kromayer lamp filtered through a nickel oxide filter, no change in the potency of the preparation is produced, even after several hours' irradiation. On the other hand, when a specimen of digitalis is irradiated with a Kromayer lamp, the rays of which are allowed to pass through a chlorine-bromine gas filter made of clear quartz, deterioration is very rapid. Tables I and II show the effect of irradiated tinctures of digitalis on the growth of *Lupinus albus* seedlings, on the one hand, and on the heart of cats, on the other.

In Table I are exhibited the results obtained with irradiations of digitalis tincture in various containers with both kinds of mercury vapor lamps. In each case, the phytotoxic index, or the degree of inhibition in the growth of seedlings produced by a standard non-irradiated tincture, kept in the ice chest, was first determined; and in comparison with the effects of such a tincture, the phytotoxic indices of the various irradiated samples are indicated. It will be noted that there was a marked deterioration in the tincture of digitalis in each case. It will be also noted that when such a tincture was placed in an ordinary glass tube, which filtered out all rays shorter than 3130 Angstrom units, no deterioration took place. Tinctures placed in glass tubes (with a qualitative limit of 2967$\mu\mu$) underwent a slight change. Light filtered through the nickel oxide, or Wood's filter, transmitting rays above 3250 $\mu\mu$, produced no change in the digitalis. On the other hand, the rays of a Kromayer lamp, which were allowed to pass through a transparent quartz cylinder, 4½ cm. in diameter and 5 cm. long, filled with a mixture of chlorine and bromine, rapidly produced marked deterioration of the drug, even though the amount of energy was enormously reduced by their passage through such a filter. In Table II are shown the results obtained by assay of various tinctures of digitalis, which were irradiated with the Kromayer lamp and tested by the Hatcher-Brodie cat method. Here, again, results similar to those described in Table I will be noted. It is interesting to observe in Table I (No. 3) that heat produced but little deterioration of tincture of digitalis. Here a sample of digitalis tincture was kept at 39°C., in the dark, for a week and was found to have undergone little change in that time.

The most interesting discovery in connection with ultraviolet irradiation was made when it was carried on progressively with a Kromayer lamp for *longer* periods of time, as will be seen from the subjoined tables and graph. It was found that when a tincture of digitalis was irradiated with the Kromayer lamp for periods varying from five minutes to one and a half hours, a progressive deterioration of the drug was effected, as indicated by the increase in the phytotoxic index when tested on living seedlings of *Lupinus albus* (See Table III.). When irradiation is continued for a longer period of time, however, the point is

TABLE I

EFFECT OF IRRADIATED TINCTURE OF DIGITALIS (0.5%) ON GROWTH OF LUPINUS SEEDLINGS

Experiment Series	Method of Irradiation	Distance from Lamp	Time of Exposure	Phytotoxic Index
No. I	1. Standard tincture, non-irradiated; kept in ice chest	--	--	68%
	2. Kromayer lamp; solution in quartz tube	10 cm.	1 hr.	74%
No. II	1. Standard tincture, non-irradiated; kept in ice chest	--	--	72%
	2. Kromayer lamp; solution in quartz tube	10 cm.	1 hr.	80%
	3. Kromayer lamp; solution in glass tube	10 cm.	1 hr.	75%
No. III	1. Standard tincture, non-irradiated; kept in ice chest	--	--	70%
	2. Heated at 39°C.	--	1 week	77%
No. IV	1. Standard tincture, non-irradiated; kept in ice chest	--	--	73%
	2. Kromayer lamp; solution in quartz tube	10 cm.	1 hr.	80%
	3. Kromayer lamp; solution in glass tube	10 cm.	1 hr.	75%
	4. Kromayer lamp; solution in pyrex tube	10 cm.	1 hr.	77%
No. V	1. Standard tincture, non-irradiated; kept in ice chest	--	--	70%
	2. Alpine Sun mercury vapor lamp; solution in quartz tube	30 cm.	30 min.	80%
	3. Alpine Sun mercury vapor lamp; solution in glass tube	30 cm.	30 min.	70%
	4. Alpine Sun mercury vapor lamp; solution in pyrex tube	30 cm.	30 min.	75%
No. VI	1. Standard tincture, non-irradiated; kept in ice chest	--	--	75%
	2. Kromayer lamp; solution in quartz tube	10 cm.	1 hr.	88%
	3. Kromayer lamp with chlorine filter; solution in quartz tube	10 cm.	1 hr.	95%
	4. Kromayer lamp with Wood filter; solution in quartz tube	10 cm.	1 hr.	78%

reached when the product formed by the photochemical reaction of the rays has a more toxic effect on the living test objects. In Table III it will be noted that continued irradiation of tincture of digitalis for periods of from one and a half hours to two and a quarter hours, inclusive, results in a product of greater toxicity than that obtained after exposure of a specimen for one and one-half hours. Further irradiation, from two and a half hours on, however, is followed by a secondary deterioration of the tincture and the phytotoxic index is seen to rapidly increase again. The accompanying Graph I illustrates the changes described above even more strikingly, showing a primary weakening of the tincture, as tested on plants, followed by a period of greater toxicity, which is again followed by a secondary deterioration in potency.

When progressive irradiation of digitalis is carried on with a Kromayer lamp and

TABLE II

ASSAY OF IRRADIATED TINCTURE OF DIGITALIS SOLUTION (1:10) ON CATS

Experiment Series	Method of Irradiation	Distance from Lamp	Time of Exposure	Number of Cats	Lethal Dose per kilo wt. of cat
No. I	1. Standard tincture, non-irradiated; kept in ice chest	—	—	3	9.2 c.c.
	2. Kromayer lamp; solution in quartz tube	10 cm.	1 hr.	3	10.4 c.c.
No. II	1. Standard tincture, non-irradiated; kept in ice chest	—	—	3	9.2 c.c.
	2. Kromayer lamp; solution in quartz tube	4 cm.	1½ hr.	3	13.0 c.c.
	3. Kromayer lamp; solution in glass tube	4 cm.	1½ hr.	3	10.0 c.c.
No. III	1. Standard tincture, non-irradiated; kept in ice chest	—	—	3	9.3 c.c.
	2. Kromayer lamp; solution in quartz tube	10 cm.	1½ hr.	3	11.7 c.c.
	3. Kromayer lamp; solution in pyrex tube	10 cm.	1½ hr.	3	10.0 c.c.

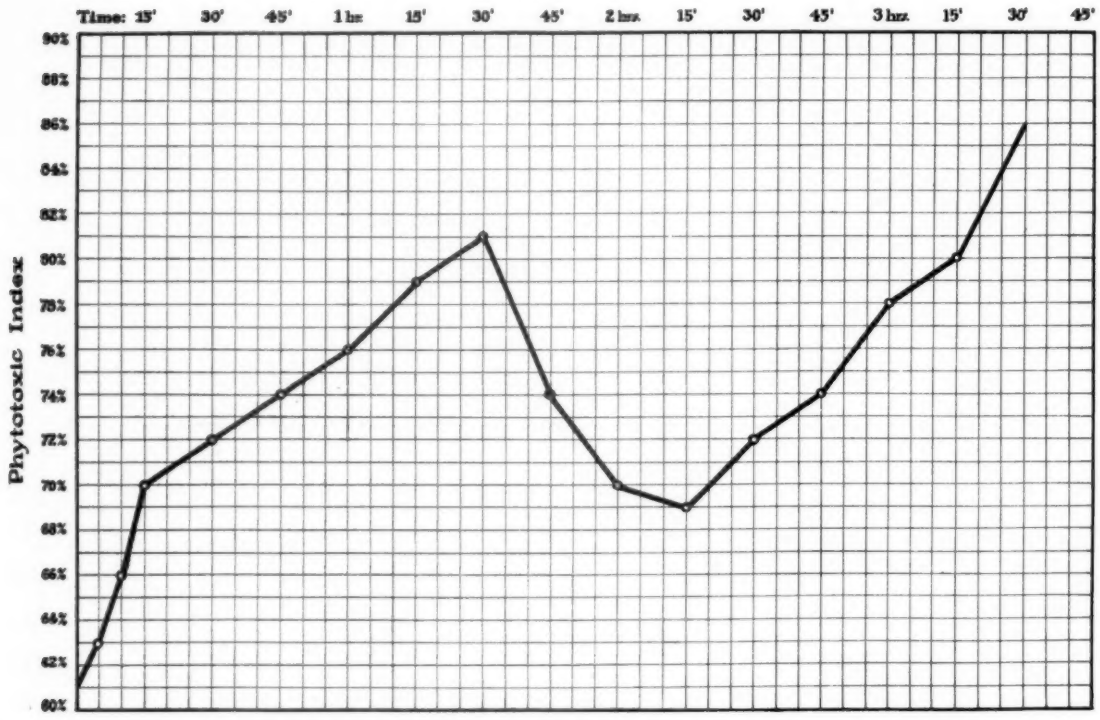
TABLE III

EFFECT OF PROGRESSIVE IRRADIATION OF TINCTURE OF DIGITALIS WITH KROMAYER LAMP — QUARTZ TUBE AGAINST THE WINDOW

Tincture Irradiated	Phytotoxic Index	Tincture Irradiated	Phytotoxic Index
(Normal: ice-box	61%)		
5 minutes	63%	1 3/4 hours	74%
10 minutes	66%	2 hours	70%
15 minutes	70%	2¼ hours	69%
30 minutes	72%	2½ hours	72%
45 minutes	74%	2 3/4 hours	74%
1 hour	76%	3 hours	78%
1¼ hours	79%	3¼ hours	80%
1½ hours	81%	3½ hours	86%

a chlorine-bromine gas filter, the changes described above occur more rapidly. Primary deterioration of digitalis can be demonstrated after fifteen minutes' irradiation. After exposure for an hour or more, however, a more toxic product is produced, as indicated by both zoöpharmacological and phytopharmacological tests; and it is only after two or more hours' exposure to rays transmitted through the chlorine-bromine filter that decrease in potency is again noted. Table IV, showing the findings obtained in cat experiments, illustrates the effect of progressive irradiation of digitalis tincture with a Kromayer lamp and chlorine-bromine filter. In Table V is shown the effect of such progressive irradiation with a Kromayer lamp through chlorine-bromine filter, as demonstrated by the one-hour frog method of assay.

GRAPH I



Effect of Progressive Irradiation with Kromayer Lamp of Tincture of Digitalis.

Effect of X-rays and Radium

The method of irradiation by means of x-rays, radium and radium emanations has been described above. The results obtained, as exhibited in Table VI, are extremely interesting when compared with the data obtained with ultraviolet rays from the mercury vapor lamp. In case of x-rays, 550 R. units passed through 1 mm. of copper and 1 mm. of aluminum were allowed to play on the tincture of digitalis for ten minutes. This exposure produced a marked weakening of the tincture for the heart of the cat. When, however, such a specimen was tested in regard to its phytopharmacological properties, it was found to be *more toxic* than the standard tincture. A similar finding was made with tinctures exposed to radium and to radium emanations, as shown in Table VI. Exposure to radium rendered the tincture weaker for the cat heart and, again, more toxic for living seedlings of *Lupinus albus*. Radium emanations produced an even more marked weakening of the tincture for cats and greater toxicity for plants.

Discussion

In Graph II, reproduced by permission of Dr. William T. Anderson, Jr., is shown the spectral energy distribution of ultraviolet radiations from a Kromayer lamp, and also the approximate wave lengths transmitted through the nickel oxide filter and chlorine-bromine gas filter. It will be noted from the experimental data described above that ultraviolet irradiations with the mercury vapor lamp produced marked changes in tinctures of digitalis, as indicated by careful quantitative pharmacological tests. It was found that such tinctures on short exposure to ultraviolet rays usually deteriorated, or became physiologically weaker in their action on living plants and animals. The very long ultraviolet rays, transmitted through a nickel oxide or Wood's filter, produced hardly any deterioration at all. On the other hand, ultraviolet radiations, transmitted through a chlorine-bromine gas filter, produced marked deterioration or weakening in the potency of digitalis tinctures. It is therefore evident that shorter rays are more active in producing photo-

TABLE IV

PROGRESSIVE IRRADIATION OF DIGITALIS TINCTURE WITH KROMAYER LAMP THROUGH CL. BR. FILTER

Time of Exposure	Lethal Dose of 1:10 Solution in Saline	Number of Cats
Standard tincture, non-irradiated; kept in ice chest	10.1 c.c. per kilo	5
0.5 hour	11.1 c.c. per kilo	6
1.0 hour	9.6 c.c. per kilo	7
1.5 hours	9.1 c.c. per kilo	9
2.0 hours	10.1 c.c. per kilo	10
3.0 hours	12.0 c.c. per kilo	8

TABLE V. FROG ASSAY

EFFECT OF PROGRESSIVE IRRADIATION OF DIGITALIS TINCTURE WITH KROMAYER LAMP THROUGH CL.-BR. FILTER

Exposure	Quantity Producing Arrest of Heart in One Hour
1. Normal tincture; kept in ice chest	0.006 c.c. per gram of frog
2. Irradiated 0.5 hour	0.008 c.c. per gram of frog
3. Irradiated 1.0 hour	0.0065 c.c. per gram of frog
4. Irradiated 1.5 hours	0.006 c.c. per gram of frog

chemical changes in digitalis than the longer ultraviolet. When irradiation of a given tincture is carried on for longer periods of time, however, the primary weakening or decrease in pharmacological potency is followed by the formation of a more toxic or potent product, as indicated by its greater toxicity for both plants and animals. Such a change in the tincture of digitalis, however, is produced only by carrying the irradiation on for a limited period of time; and a still longer exposure to the same rays produces a secondary deterioration or weakening in the pharmacological activity of the specimen. It is therefore evident that progressive photochemical changes occur in tincture of digitalis on exposure to ultraviolet rays; and it is possible that more than one such process may be going on at the same time. This can only be finally established, however, by studies with a quartz monochromator and an inquiry into the effects of individual bands of different wave

TABLE VI

EFFECT OF X-RAYS AND RADIUM

Method of Irradiation	ZOOTOXIC EXPERIMENTS Lethal Dose of 1:10 Dilution per Kilo of Cat	PHYTOTOXIC EXPERIMENTS Inhibition of Root Growth of Lupinus Seedlings by 1 per cent Solution
I. Standard tincture, non-irradiated; kept in ice chest	10.1 c.c. per kilo	61 per cent
II. Exposure to x-ray for 10 min. 550 R. units passing through 1 mm. of copper and 1 mm. of aluminium	11.2 c.c. per kilo	55 per cent
III. Exposure to radium in copper container. 1356 millicuries for 13 hours, or 17.6 gram hours	11.3 c.c. per kilo	54 per cent
IV. Exposure to radium emanations for 20 hours.		
1. 3 millicuries in 10 c.c. of tincture	-----	53 per cent
2. 5 millicuries in 10 c.c. of tincture	12.1 c.c. per kilo	49 per cent

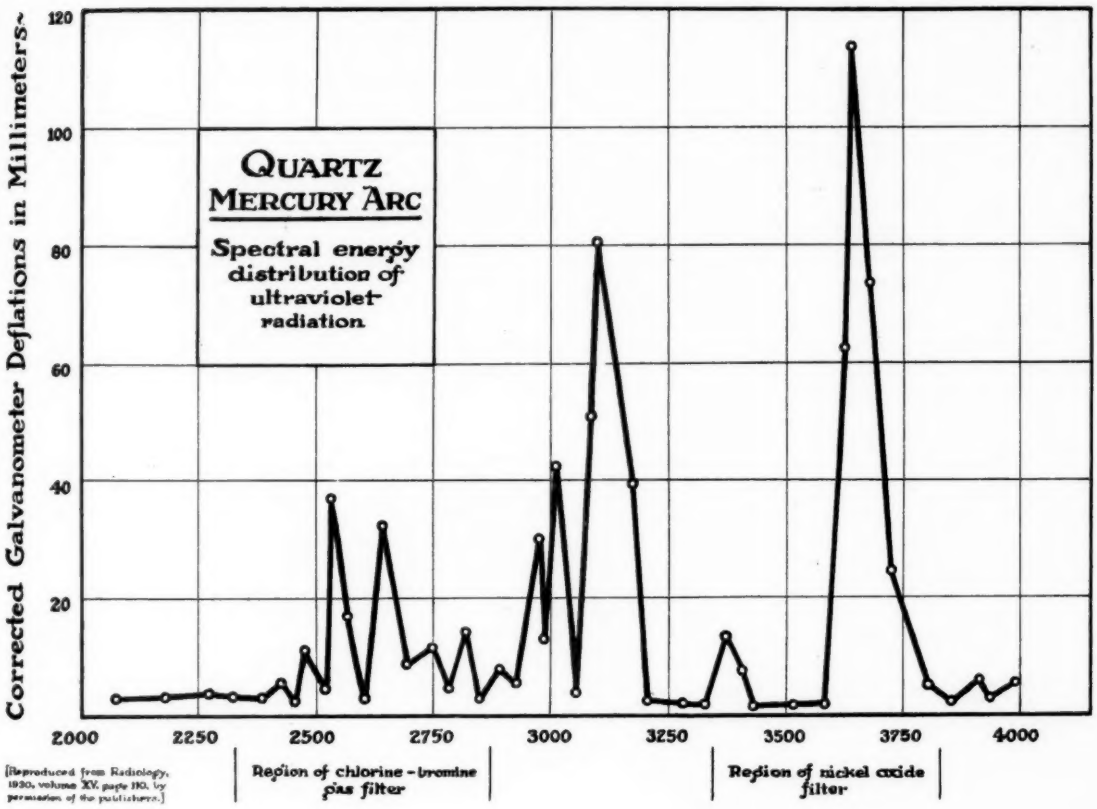
lengths emitted by the ultraviolet source. The author proposes to make such a study as soon as suitable apparatus becomes available.

The effects produced by x-rays and radium differ from those obtained by the longer ultraviolet rays in that the photochemical changes effected in the tincture of digitalis result in a product which is much *less* potent for animals but much *more* toxic for plants. It will be noted also that the effect of exposure to radium itself is very much like that obtained by exposure of the tincture to x-rays. On the other hand, radium emanations, introduced directly into tincture of digitalis, produce more extensive photochemical change, which is undoubtedly due to the presence of alpha and beta particles in addition to the gamma rays in the emanation.

In conclusion, it must be emphasized that although a given tincture of digitalis, deteriorated or physiologically "weak," may be potentiated or rendered more toxic for plants and animals by prolonged exposure to certain ultraviolet rays, it does not necessarily follow that such a preparation is *therapeutically* as efficient as a freshly made, untouched standard tincture of digitalis leaf. The photochemical changes produced by the irradiation certainly result in the formation of products which render the tincture more toxic when administered in large doses. Whether small doses of the irradiated drug will produce desirable medicinal effects, however, will have to be determined by numerous additional experiments with smaller doses in the laboratory and especially by carefully controlled observations on human patients in the clinics. With this reservation in mind, it may be permissible to state that a number of experiments already carried out in this laboratory seem to indicate that a weak digitalis tincture, when irradiated with ultraviolet rays passed through a suitable filter, was not only more potent in respect to its killing dose for frogs and cats but also more efficient in therapeutic doses for animals. This was indicated by the earlier onset and more marked manifestation of the so-called second stage of digitalis action or the stage of vagus inhibition. The set of experiments described below will serve as an illustration.

Part of a weak tincture of digitalis was

GRAPH II



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irradiated with a Kromayer lamp through a chlorine-bromine gas filter for a period of from one and a half to two hours. The irradiated fraction was then compared with the original weak tincture by various pharmacological methods and gave the results shown below:

1. Assay on frogs revealed that the dose of digitalis required to produce systolic standstill of the heart in one hour was 0.0085 c.c. per gram. The irradiated fraction required 0.00725 c.c. per gram of frog or, in other words, was more potent.

2. Experiments on cats showed that 8 c.c. of a 1:10 dilution of the original tincture per kilo weight of the animal were required to produce the maximum vagus inhibition (average of three cats); and the minimal lethal dose of the original digitalis solution was 16.5 c.c. per kilo weight of the cat. The irradiated tincture, on the other hand, required only 5.5 c.c. per kilo of the 1:10 dilution to produce the maximum vagus inhibition (average of three cats) and gave 12.5 c.c. as the minimal lethal dose per kilo weight of the cat.

3. Phytotoxic index of the original tincture from three series of experiments gave an average of 66 per cent. The irradiated tincture in the same number of experiments gave a phytotoxic index of 52 per cent.

4. In addition to the experiments on frogs, cats and plants, the two specimens of digitalis were compared in regard to their toxicity for goldfish by a modified method of Pittenger and Vanderkleed,[17] and the results thus obtained also corroborated the findings on cats and frogs.*

Investigations on this subject will be continued because of its obvious importance from both the scientific point of view and the standpoint of practical therapeutics.

Summary

1. Tincture of digitalis was irradiated with mercury vapor quartz lamps, with x-rays and with radium.

* When this manuscript had been completed, the writer was pleased to find in the *Berichte über die Gesamte Physiologie und Experimentelle Pharmakologie* (1931, 61, 327) a reference which indirectly confirms the findings noted above. Three Japanese investigators, Ito, Ryoichi and Bunjiro Teroda, from the pharmacological laboratory of the University of Mukden, report experiments on the effect of ultraviolet irradiation on adrenalin. These writers state that irradiation of adrenalin with ultraviolet rays under certain conditions renders it at first more active and that this primary potentiation is followed by secondary destruction or weakening of the drug after further irradiation.

2. Irradiation with ultraviolet rays for short periods of time produces a deterioration or weakening in the pharmacological potency of the tincture, as tested on living plants and animals.

3. On progressive and prolonged exposure to ultraviolet rays, a point is reached when the photochemical changes result in the formation of products exhibiting a greater toxicity for both plants and animals. This stage, on still further exposure, is followed by a secondary weakening in the pharmacological potency of the irradiated tincture.

4. The shorter ultraviolet rays, particularly those transmitted through a chlorine-bromine gas filter, are more effective than the longer rays in producing the changes described above.

5. Exposure to x-rays, to radium, and to radium emanations results in a product which is greatly reduced in its activity for the animal heart, on the one hand, but is greatly increased in toxicity for living plant protoplasm, on the other.

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Prof. Einstein Offers New Theory of Matter and Space

To a distinguished audience in the main hall of the Vienna Institute of Physics and by microphone to two other rooms, Prof. Albert Einstein on the evening of Oct. 14 explained the present status of his relativity theory and embarked on a remarkable speculation about the extent and shape of space.

Einstein spoke of calculations he had made which seemed to indicate that the universe, if it were expanding, must have started with no volume at all and must ultimately again contract to no volume. Reviewing his recent works, Einstein announced he had succeeded in assembling gravitation and electrodynamics in a unified theory, but his hope of being able as a result to close the gap between the quantum theory and the relativity theory had been disappointed.

"The farther the heavenly bodies are away the less is their luminosity. Also they recede from us the more rapidly the farther away they are. This led a Russian mathematician to conclude that all visible material is in a process of expansion."

Professor Einstein says this expansion could be measured. He declared that if his conclusions were correct the world, which is now in a process of expansion, must have started from nothing at all, which seemed impossible. To reach its present size it would have taken from one to ten milliard years.

As for the future, Professor Einstein said his calculations proved that the earth would reach a certain limit of expansion. Then the process would be reversed, and it would shrink back to its original nothingness.

THE THERAPEUTIC EFFECTS OF PHYSICAL EXERCISE * ** †

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Living close to nature, eating simple, rough food, frequently exposed to the elements, often beset by dangers from warring neighbors, primitive man was ready to flee danger or to defend himself in an emergency. Civilization has brought about specialization. One group fights our battles, another group watches over our safety while we sleep, many others each have a small part in the manufacture of the various commodities which we use. The demands for aggressiveness, defense, or even activity of self-service steadily tend to decrease. As a result of this modern manner of living, most of us have little endurance and our muscles have become weakened.

Certain diseases likewise help to bring about atonic musculature—among these are hypothyroidism, anemia, chronic debilitating diseases such as tuberculosis, and a very prevalent condition known as chronic laziness which is often sporadic, sometimes endemic, and affected by both climatic and economic conditions. We know that with a decrease of muscle tone there is a tendency for the normal centers of gravity in the body to become shifted. The pelvis tilts forward, the lumbar spine is displaced forward with a compensatory curvature of the dorsal spine resulting in rounded shoulders and decreased chest capacity. As the condition advances the abdomen protrudes more and more.

Such muscular weaknesses and consequent postural defects are prevalent among persons who are underweight. The diagnostician periodically seeks to inventory these individuals, investigating the five great systems by an examination which is mental, chemical, and physical in scope. The defects are classified as functional or organic, and the decision is reached as to whether the impairment is of major or minor importance. It is significant that for many years account has been taken universally of pulse rate, blood pressure, temperature, and gait if the patient can walk. Too often the diagnostician is content if the patient can walk comfortably, and does not attempt to find out whether he can walk fast for a sustained period of time, or whether he can carry a load. Some machines are best tested both with and without a load. Likewise in the human machine more and more attention is being paid to tolerance tests of function, such as the glucose tolerance test, the urea tolerance test, tests of salt tolerance and water diuresis, and tolerance to exercise. In some patients whose physical condition is obviously impaired but in whom no organic disease is present, with reservations the accusing finger may be pointed to such findings as enlarged tonsils or dead teeth. Not unwisely these foci of infection are sometimes removed as possible causes of underweight, subnormal metabolism, low blood pressure, fatigability, etc. Constructive therapy in such cases must be directed toward increasing the efficiency of the vascular system while increasing the tone of the skeletal musculature. The human machine can be no more efficient physically than the respiratory - cardiovascular mechanism. Significant functional efficiency data must be collected on these two systems at rest and following work. The data must be evaluated in the light of clinical symptoms and physical findings. The overzealous protection of a weakened heart may only serve to increase the patient's disability. The patient's capacity for work must be determined and not exceeded. By properly graded physical exercise with a gradual increase of the work done, the physical endurance can be greatly increased and susceptibility to disease and to overwork decreased. Thereby the individual's kinetic drive is greatly increased by the following series of co-ordinated events: an increase of vital capacity of the lungs, increase in cardiac stroke volume and output, increase in working pulse pressure, better oxygen transportation and more efficient utilization of oxygen in the

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† From the Department of Urology, Research Division, Cleveland Clinic Foundation.

tissues. The clinical benefits of the exercise become conspicuous long before these anatomic events are obvious. These benefits are of a physiologic nature and are due to increased pulmonary ventilation, marked increase of blood flow to the working parts, causing a flushing out of the cell and a partial renewal of its structure as a result of a several fold increase of its metabolism. Let us consider in detail some of the criteria of physical fitness.

Kahn, Kahn and Rosenbloom (1920) have collected in book form a large number of tests for functional diagnosis. Gillespie, Gibson and Murray (1925) observed that one hour's work, totaling about 25,000 kilograms daily, elicited a lesser increase in pulse and respiratory rate with six days training. The effect was not lost in periods of from 16 to 26 days of omission of the exercise. They noted quantitatively that the greater the amount of work done in a given time the slower was the return of the pulse rate to normal. They also noted that the pulse rate after exercise was greater if the rate of performance of work had been greater, and that the rise in blood pressure was proportional to the load in an individual. Of course, in different individuals the same load will elicit different degrees of response depending upon physical efficiency. Various workers have shown that the pulse rate of a well-trained athlete is slow when the subject is in the recumbent position, and that it increases but a few additional beats per minute upon standing; the increase upon mild exertion is also very slight. In general, in the physically unfit subject the basal pulse rate is more rapid, the increase on standing is greater, and the return to the previous rate after exertion is slower. In such a subject the vital capacity is also diminished.

Blood Pressure

Debility due to various causes usually is associated with low blood pressure in persons who are underweight. A basal systolic blood pressure of 100 mm. of mercury is not necessarily low if the pulse pressure is 30 to 40 mm. mercury. If, however, on standing there is a considerable decrease in the pulse pressure, say to 30 to 50 per cent, the condition is an indication of debility. The evidence is more positive if the pulse rate is rapid, or if the pulse rate increases excessively on standing. In such cases the test exercise is useful. If this test proves burdensome to the patient, causing dyspnea or marked fatigue, physical impairment is obvious, and in such a case the pulse rate may increase excessively with a slow return to normal. However, if the debility is due to marked hypothyroidism, the pulse rate will often be subnormal and will return quickly to the normal rate after exertion. If the pulse pressure increases to 50 or 60 mm. mercury with the test exercise and returns rapidly to a level not appreciably less than basal, it is a good sign of physical endurance, or an indication that endurance may be built up readily. The test exercise quickly gives information as to whether the cardiovascular system is hyperdynamic, normal, or hypodynamic by comparison with a standard response.

Oxygen Consumption in Response to Exercise

This is evaluated in terms of calories per hour per square meter surface area and indicated in percentage of the normal standard for basal conditions.

Bowen and Carmer (1926) state that the basal metabolic rate is the most influential single factor in determining the amount of oxygen used during exercise. They observed that subjects with cardiac insufficiency showed a slower decrease in oxygen consumption after exercise. This finding is consistent with a delayed transportation of needed oxygen to the working tissues. Peabody and Sturgis (1922) noted that in normal and cardiac patients taking the same amount of exercise there was little or no difference in the effect of exercise on the amount of oxygen consumed, but the return to normal of the minute volume of the respiration and of the heart rate was delayed in the cardiac patients. Grönholm (1925) observed the effect on oxygen consumption of 15 to 30 minutes dancing. In the case of the waltz or shimmy the increase was fourfold; in the case of the polka and mazurka it was tenfold.

In a group of Cleveland clinic employees, all relatively healthy, there was a very great variation in the amount of oxygen consumed immediately following the test exercise. After the exercise the oxygen consumption decreased somewhat parallel with the decrease in pulse rate and blood pressure so that within from three to five minutes the oxygen intake was near the rate of the previous basal level.

In some instances it was definitely lower within four or five minutes. The findings regarding the rate of paying off the oxygen debt for the standard exercise are too variable to be used in diagnosis unless associated with other indicative phenomena. In other words, a delayed return to normal of pulse rate and blood pressure, especially associated with a sustained high oxygen consumption after exercise would indicate cardiovascular impairment.

The Functional Efficiency of the Circulation as a Whole

The human machine can be no more efficient than the cardiovascular-respiratory systems. We all know that energy is derived from the combustion of dextrose in the cells where work is done. There must be a rapid and constant supply of oxygen to support this combustion when the rate of work is increased. The oxygen supply must be proportional to the rate of combustion. There must also be an equally efficient carrying off and excretion of the by-products. How well the mechanism will function under stress will depend upon several factors:

(a) The strength of the heart as a pump, and the quality of its response under stress.

(b) The volume of blood circulating, its quality, and its content of hemoglobin.

(c) The strength and tonicity of the vascular bed as a whole, its reactability to local increased demands.

If all the above conditions are satisfactorily met, there will still be a physical deficiency if there is poor utilization of the oxygen in the tissues as in untreated hypothyroidism of marked degree. If the individual is so afflicted, or has a very low basal metabolic rate from an unknown cause, the demand for oxygen in the tissues will be small. If he does not indulge in some sort of physical exercise the oxygen demand will continuously remain relatively small, the heart will meet this demand with a minimum of effort, shallow breathing will suffice, small vital capacity will result, the lazy heart, the action of which is often slow, will suffer partial atrophy from decreased use. Such a deficiency is to be found in a large percentage of sedentary workers. In the present study, conducted on Cleveland clinic employees, several types of exercise were used.

Types of Exercise

The *test exercise* was used for diagnosis only. The subjects omitted breakfast, rested in bed for 30 minutes, after which the average blood pressure, pulse rate, and a basal metabolism test were taken. The subject then stood for two minutes and pulse rate and blood pressures were taken until the reading was constant. Still standing the patient then executed stationary running, 60 hops in 30 seconds, by a metronome, after which the metabolism apparatus was immediately attached, with the subject in the recumbent position. Normally the immediate readings of pulse rate, blood pressure, and oxygen consumption were relatively high and underwent a rapid decrease.

Therapeutic exercise, when indicated consisted of one or both of two types: (a) corrective exercises for faulty posture, (b) daily classes in calisthenics using the "setting-up" type of exercise for a period of 15 minutes.

Specimen cases will best illustrate the use of these exercises.

Case Reports

Case 1. A woman, 27 years of age, of a hypokinetic personality, was 10 per cent under weight, was easily fatigued, had flabby muscles, lumbar lordosis and flat feet. Basal metabolism readings taken between January 18th and August 30th varied between —20 and —24. Basal blood pressure averaged 100/65. With the subject standing there was a decrease in the pulse pressure of approximately 30 per cent due chiefly to lowering of the systolic pressure. After the subject had stood for a long period cyanosis and edema of the feet developed, associated with marked fatigue. The recumbent resting pulse dropped as low as 56 per minute.

Diagnosis: Hypothyroidism with arterial hypotension and blood ptosis. A course of "setting-up" exercises for fifteen minutes daily, except Sundays, for one month, resulted in the following benefits:

(1) A gain in weight of five pounds.

(2) A decrease in blood ptosis represented by an increase in the standing pulse pressure.

(3) Increased capacity to do physical work.

(4) Increase in the amount of oxygen consumed during recovery from the test exercise.

(5) Increase in pulse pressure resulting from the test exercise, this being effected by a lowered diastolic pressure together with increased systolic pressure during exercise.

(6) Improvement in physical appearance.

The diagnosis of hypothyroidism was strengthened by the fact that considerable further subjective improvement was derived from the daily administration of two grains of Armour's desiccated thyroid gland without the appearance of any cardiovascular disturbance.

Case 2. A woman 22 years of age, 10 per cent under weight, a sister of the subject of Case 1. Several readings of basal metabolic rate were minus 10 per cent. The body musculature was somewhat flabby. Basal blood pressure averaged 104/60, pulse rate 72. There was edema of the lower extremities but no cyanosis when the patient stood for a long time. Constantly on standing the blood pressure dropped to 86/66 with a consequent decrease in pulse pressure of approximately 50 per cent. Frequent dizziness was noted with a tendency to faint easily. The standing pulse rate was excessively high, often varying between 96 and 116, sometimes only 88. Response of pulse rate and blood pressure to the *test exercise* was satisfactory, the blood pressure rising to 132/62, the pulse rate from 72 to 84.

Diagnosis: Static circulatory asthensia. The dizzy spells were due to poor cerebral circulation when standing. The tachycardia when standing was probably due to an excess of carbon dioxide in the medulla, associated with cerebral anemia. This contention is supported by the fact that the recumbent pulse rate was slower immediately after exercise than the resting standing pulse rate. The basal metabolic rate of —10 and the oxygen consumption of plus 201 per cent immediately after the test exercise were within normal limits.

Posture was considerably improved by posture exercise—re-education of proper muscles. "Setting-up" exercises six times weekly repeated 29 times gave the following results:

(a) Increase in weight 2 pounds.

(b) Increased capacity for work, both mental and physical.

(c) No change in cardiovascular findings; dizziness and blood ptosis persisted.

In case 2 neither harm nor additional benefit was derived from the daily administration of Armour's desiccated thyroid gland, 1 grain. Diagnosis: constitutional static circulatory asthenia. This is not a kinetic asthenia, for exercise was tolerated well. The treatment consists of eradication of any existing foci of infection followed by physical therapy (a) special exercises to assist in maintaining correct posture (b) continuation of a regular program of mild exercise daily, the intensity to be gradually increased (c) a suitable balanced diet with high caloric intake. Such a program has a distinct value. It must be borne in mind that we can not make of this subject a marathon swimmer, but we can enable her to meet the average physical demands of life.

Case 3. A woman 19 years of age, 13 per cent underweight was very easily fatigued. Several readings of basal metabolic rate on different days were —10 per cent, or within normal limits. The response of blood pressure, pulse rate, and oxygen consumption to the test exercise was satisfactory. Readings of blood pressure in the basal state were normal, and upon standing there was no blood ptosis. The results of taking the "setting-up" exercises daily for 29 times were as follows:

(a) Increase in weight of 8 pounds.

(b) Increased capacity for work, both mental and physical.

(c) Marked improvement in appearance.

The usual tests revealed no essential change in blood pressure, pulse rate, and basal metabolism as resulting from the course of exercise. The exercise habit was continued and the weight which was gained has been maintained for a period of one year to date.

Case 4. A woman, 42 years of age, height 61 inches, weight 120 pounds. Several readings of basal metabolism averaged minus 20. There was a very noticeable ptosis of the right eyelid, puffiness about the eyes, and a recent tendency to gain weight in spite of a restricted diet. There was a deep-seated nodule about one inch in diameter in the left lobe of the thyroid which was easily palpated. Basal blood pressure averaged about 100/68. Due to a marked drop in systolic pressure on standing the pulse pressure usually decerased 25 to 30 per cent. Associated with this finding was the fact that the patient had experienced marked fatigue for some time when on her feet. "Setting-up" exercises taken for a period of 15 minutes daily for three weeks greatly reduced the fatigue and increased the capacity for work so that evening work could be done without imposing a burden. The body weight, however, increased 3 pounds. Basal metabolic rate, pulse rate and blood pressure were essentially unchanged by the course in exercise, although the physical appearance was much improved. Armour's desiccated thyroid was administered in gradually increasing doses so that within 90 days the daily dose was up to 4 grains. The maximum benefit was noted when the dose reached 4 grains, and this dose was maintained. After several months thyroid was discontinued and a relapse occurred. Thyroid therapy was resumed on Feb. 9th, increased gradually to 4 grains by May 27th, and thos dose has been maintained to date. There was a loss of 9 pounds which was regained; endurance is much increased, the appearance of the subject is greatly improved, and the ptosis oculi is not now apparent. The basal metabolic rate readings vary but remain within the range of normal.

Summary

In addition to basal pulse rate and blood pressure studies with the subject in the recumbent position, three types of exercise have been used in this investigation, (a) a physical efficiency test for diagnostic purposes, (b) exercises for correction of faulty posture, and (c) daily setting-up exercises for toning up the musculature and the cardiovascular system.

1. A review is made of some of the criteria of physical fitness.

2. It is shown that physical exercise can

be used to impose a load on the human machine and the cardiovascular responses thereto may be evaluated as an index of physical efficiency.

3. Sedentary workers who take insufficient physical exercise acquire atony of musculature and of the cardiovascular system.

4. A period of fifteen minutes of calisthenics daily produces no significant change in the cardiovascular findings in one month, but the effect of such daily provocation of increase in the metabolic rate is decidedly beneficial in that most persons who are underweight gain weight, appetite is augmented, tendency to fatigue during the day's work is lessened, tolerance to exercise is increased, the amount of sleep required is diminished, and there is an increased fitness for evening pursuits.

It is concluded that the earlier benefits from systematic daily exercise are manifested by a better utilization of the oxygen supply during activity, and that more prolonged training results in a much greater supply of oxygen to the tissues.

Thanks are extended to all who participated in these experiments. The posture exercises were conducted by Miss Anna Wetterhuus. The calisthenics were directed by Mrs. C. Stoner. Miss E. Mick assisted with the metabolism tests.

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Discussion

Dr. F. H. Ewerhardt (St. Louis, Mo.): I was very much interested in this paper because I have been doing considerable work along that line myself. There has been a great deal of work done in regard to the physiologic effect of exercise on the human system, but most of this has been done in connection with normal persons; at least, they were not pathologic, but persons who had no organic or functional disturbances.

A great fund of information is at our command and an attempt has been made to use this information in evaluating the vital capacity or the physical efficiency of a given individual.

I took part in such an attempt on the part of an industry two years ago when we took 300 employees of a factory and attempted to daily give these people vital capacity or physical efficiency tests, with the view of determining whether or not a given individual might show evidences that he was in a position to carry on his work. It was an interesting piece of investigation, but was discontinued because it took too much time. The time-consuming element was a little too much for the industry. I am inclined to think if we persist in this sort of research, perhaps eventually we might formulate a very simple scheme whereby we could tell in a matter of three or four minutes, in a general way, whether a given individual is up to normal standard or not.

Very little has been done in regard to this type of work on pathologic conditions, and the effort of Dr. Johnston's paper is to be commended because he is attacking the theme along that line. I hope he will continue it and at some future time perhaps give us a little more data. I should like to see him carry on the work and run his cases into the hundreds. Three or four or even a hundred is hardly enough from which to formulate conclusions. If we had the careful deductions of blood pressure, pulse rate, metabolism, in connection with several hundred people over quite a long period, it would be a valuable addition.

I was very much interested in the therapeutic results obtained from these studies. He concluded that when a given weight was below par, it was in need of exercise; and he proceeded to elevate the efficiency of that individual by exercise. The reason I am particularly interested in this study was because he showed the effect of posture exercises. I am certain if he had had time he could have given us a great deal more of interesting and instructive information on that phase of therapeutic exercise. We see a great many patients in our hospitals and outside, men and women, just a little bit below par. They are susceptible to disease. They cannot carry on their work as they should.

The question is what shall we do with these individuals? Shall we drug them? Many people don't like that. We have found that by giving them a course of exercises in connection with supplemented hydrotherapy, that we sometimes have accomplished astonishing results with these men and women. As an example, a man came in and said, "I can't continue my labors after three o'clock." He found himself exhausted at that time of day. He was examined very carefully. Nothing was found organically wrong with him. He was sent to me. I took a shadowgraph and discovered he had an atrocious posture. He

had the typical swayback, pot belly, flat chest, bag tied-in-the-middle defective look. That man was put on some postural exercises. That is all he had. Inside of a month there was as big a difference as there is between day and night.

It seems to me that if we would keep in mind the possibilities of therapeutic exercise it would be quite worth while. The man wasn't seriously ill but I think he was at a stage where he might very easily have become ill.

Dr. J. H. McCurdy (Springfield, Mass.): This splendid paper sets forth clearly in the Introduction of some of the leading problems of exercise brought about by the changes in environment and in activity. It emphasizes the loss of muscle tone and the changes in center of gravity.

The postural problem has to date been less satisfactorily handled than many problems. We need:

1. *Better Methods of Measuring Correct Posture.*

At Springfield we have devised an apparatus which is a combination of the ideas presented by Demeny in his conformature and by Fradd in his silhouetteograph. This combination takes the silhouetteograph picture and measures at the same time with rods against the spine the conformation of the antero-posterior spine. The instrument measures accurately such postural positions. It avoids the assumption that the flesh line in the silhouetteograph is similar to the postural position of the spine. The instrument reduces the errors to a very small minimum, considerably smaller than any other instrument. It is now necessary to study with the accurate instrument the types of posture. Dr. Johnston has called attention to the clinical features of poor posture.

2. *Improvement in the Short Static Contractions as an Aid to Good Posture.*

This material was presented at this Congress, in St. Louis, last year. It makes clear the ability of the patient to improve very materially his short static contraction ability. This was published in the ARCHIVES OF PHYSICAL THERAPY, X-RAY, RADIUM for February, 1931.

3. *Objective Measurements of Actual Shortening of Muscle.*

The Graduate Department at Springfield has a preliminary instrument for measuring the amount of shortening of muscle, immediately following the different types of exercise and the permanent shortening after period of training.

It is hoped that these three elements, the combination of the picture and conformature method, the improvement in the short static strength and the actual measurement of shortened muscle, will make more objective and definite the corrective exercise problem.

Functional tests of physical exercise should be considered in connection with

Heart Rate

1. Small increases on changing from lying to standing position, indicate good cardio-vascular ability.

2. Rapid recovery after a moderate standard exercise is indicative of cardiac ability.

3. Small immediate increase after standard moderate exercise indicative of cardiac ability.

4. Slow heart in general indicative of heart power, though the chief measure with a heart between 60 and 75 in the standing position should be a comparison of the horizontal and standing rates and a comparison of the effect of a standard exercise.

Blood Pressure

1. Increased resting systolic pressure in changing from lying to standing is a good index. This ordinarily increases from 2 to 8 mm.

2. Decrease of resting systolic pressure on changing to standing position indicates poor cardio-vascular adjustment. This may be temporary due to previous moderate exercise of an hour or more, or due to considerable standing before coming to examining room.

3. Decreased pulse pressure on standing is indicative of poor cardio-vascular ability. This has been shown particularly by Karpovich in both the resting position and after golf. He showed the greater the exhaustion the greater the decrease. (See *American Physical Education Review,* November, 1928.)

4. Decreased diastolic pressure on standing seems to be indicative of poor condition. This was also shown by Karpovich, in the same article.

Respiratory Index

1. Inability to hold up a column of mercury 20 mm. for 35 to 50 sec.

2. A marked decrease in ability to hold the column of mercury up 20 mm. after exercise is indicative of poor condition; and after standard exercise, e. g., the stair climbing as given in the Flarimeter tests, it ordinarily drops considerably below. With knee-raising 20 times in 10 sec. with normal individuals it would run from, for example, 50 sec. before exercise to 20-25 sec. after exercise in holding ability. For particulars regarding the Flarimeter test as used by the Prudential Life Insurance Company, see pamphlet "Determining Circulatory Fitness," Flarimeter Tests, Revision of June, 1931, as published by the Prudential Life Insurance Company.

Dr. Luther A. Tarbell (New Haven, Conn.): For a number of years I have been interested in therapeutic exercise and physical education. Before I studied medicine I was a student of Dr. McCurdy, and learned to appreciate its value as an adjuvant measure in therapeutics.

Dr. McCurdy, I know, often was able to pick out the condition of his athletes, and especially his football men, by their pulse and blood pressure response before and after exercise. I think there is a great deal of work which can be done along that line. Very recently I have had as a patient, a man of international reputation who had a metabolism reading of minus 30. He was a man well along in years, and although he had a very low metabolic rate he really was a mental giant. But he felt himself "slipping," and because he had almost died of tuberculosis in 1898 and was very weak, he had always been cautioned about the matter of exercise.

Another thing which I learned from Dr. McCurdy was that by measuring the time in which the pulse rate and blood pressures will return to normal, we can get a definite measure which

we can give our patients if they use enough exercise. For instance, if we find on giving them a certain amount of exercise that their blood pressure or pulse pressure does not return to normal in a given time, that patient has had too much exercise for that given individual and it must be cut down. Taking them over a carefully graduated series of exercises we can benefit them and greatly improve their condition over a given time. This patient, of whom I have just spoken, at the present time is able to do a lot of physical work. He participates in a few rather strenuous games and can now readily climb stairs, which he was not able to do before. Gradually increasing his exercise, I have carefully watched these points which have been brought out, which I often use in my athletic work and have found that it can be used as very helpful indices, sometimes, as to the amount of exercise the patients can be given.

Dr. Robert L. Johnston (Cleveland, Ohio), closing discussion: I was glad the last discussant brought out the point about graded exercises, because the main point I was trying to emphasize was that one important difference between an asthenic (or cardiac) patient and a normal subject was how he would respond to a certain test exercise. If a standard exercise was followed by a type of response which a much heavier exercise would bring about in a normal subject, it meant the patient had not been accustomed to doing the equivalent thereof and was incapable of doing it for an extended period of time.

However, by going way back, as you would with a diabetic, to increase the glucose tolerance, and beginning with an easy exercise, gradually stepping it up, you could increase his capacity for work and gradually tone up those asthenic muscles, thereby bringing about greater cardiovascular strength and greater physical endurance.

THE IMPORTANCE OF STATIC MASSAGE FOLLOWING DIATHERMIA *

J. E. RUETH, M.D.

MILWAUKEE, WIS.

Man's mental life is like a mountain range with high peaks of knowledge and deep valleys of ignorance. We are here and live and must die. We work according to our ability and will, but we do not know why we are here and what makes us live, or die. We think, invent, develop ideas, and our intelligence, applying force to matter creates everything we possess, from aeroplanes to submarines. But we still do not know the nature of force or matter.

Our two greatest modern servants are oil and electricity, but no man knows, actually, whence oil came, or how it was produced. Think of the many things accomplished with oil in everyday life. Electricity bears with oil and coal the burden of man's industrial labor. The power of electricity drives machinery, produces heat and also extreme cold; it carries knowledge and music over the radio, carrying a message around the world seven times in a second. We talk across the ocean by telephone, using the waves of electricity as our messenger; it kills the criminal in the death chair; it combats disease when scientifically applied to the living flesh. But what is electricity? We do not know.

The use of electricity, applied to the practice of medicine, is not new. Static electricity was used rather extensively 30 or 40 years ago, but, naturally, was discarded because its application was not understood or based on scientific knowledge of the physics involved. The static breeze was used then for the neurotic patient. The only benefit that could be derived from this breeze would be psychic. With little or no knowledge of the use of static electricity as it is applied at the present time, and its effect upon the animal body, its use rapidly declined.

Thirteen years ago, however, these conditions underwent a change. The U. S. Army Hospitals, faced with a constantly growing number of incapacitated men whose disability was due almost totally to trauma, accepted Physical Therapy, experi-

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mentally at first, and finally with enthusiasm.

In this revival, or more properly, the first rational experiment with Physical Therapy, the high frequency current and static electricity played an ever-increasing part. New methods of application, proper control, and more efficient electrical equipment rapidly broadened the field of its use and the evaluation of its results.

The importance of static massage, following diathermia, being the topic of this paper, I wish to first give a brief review of the physics and physiology of diathermia.

Physics and Physiology of Diathermia

Diathermia, meaning to heat through, is the name applied by Nagelschmidt to the clinical application of high frequency current. The physical attributes of this type of current differ radically from all other types used therapeutically. High frequency current, that is, one in which the direction of flow alternates at a high rate of speed, usually 1,000,000 to 3,000,000 waves per second, does not excite muscular contractions, nor does it set up, so far as is known, chemical changes in the tissues which it may traverse. This absence of chemical change and muscular contractions in no way interferes with the characteristic phenomenon of all electrical currents traversing a resistant body; namely, the production of heat within the resistant body, i.e., the transformation of electrical into thermal energy. As may be seen, we have at our command a method of producing heat within living tissue. Within rather well defined limits, we may direct this heat to any part of the body we wish, and produce any desired temperature therein.

The factors limiting our control of the heating of tissues should next engage our attention. They may be pointed out briefly as follows:

(1) The amount of current traversing a given area (amperage). This factor is easily controlled by the size and shape of the electrodes applied to the body, and is limited by the electrical output of the machine.

(2) The voltage, or electrical pressure, of the current. Just here I should like to state that I have found that under no circumstance will a low voltage current do the work of a high one. I am aware that in this I disagree with many men, but clinical experience has shown me that a machine capable of giving only low voltage current (up to 20,000 volts) will not give anything like the results that the machine capable of producing 50,000 or 90,000 volts.

(3) The vascularity of the area traversed by the current. Obviously, the greater the vascularity, the greater will be the number of heat units removed from the part by the blood. Therefore, bone cartilage, and fibrotic tissue will be heated to a greater degree than surrounding vascular tissue.

On the above factors rest our therapeutic success or failure. Given an electrical apparatus that is capable of delivering to our patient a true high frequency current, free from chemical and muscular effects, and of sufficient quantity (amperage) and pressure (voltage) to do the work asked of it, we are able to benefit those conditions within the human body which will derive benefit from the physiological effects of diathermia which follow:

(1) The rapid production of an intense (arterial) hyperemia.

(2) The reduction of pain caused by ischemia.

(3) The increase of local metabolism.

(4) The increased number of phagocytes brought by both the increase in blood supply and local heat.

(5) Increased general metabolism following the radiation of heat through the blood stream.

(6) Softening effect of heat upon inflammatory exudates in the tissues lying within the effective path of the high frequency current.

It is obvious that those pathological conditions, which may be reasonably expected to be corrected by the above physiological changes lie within the indication for diathermia. Equally obvious is the fact that only disappointment will follow the therapy where none of the physiological effects is sufficient force to correct the pathology. A common instance may here be cited with profit. A patient with a neuritis, arthritis, etc., is treated with diathermia and other appropriate physical measures, but no account is taken of his several infected teeth, nor of a pair of infected tonsils. To expect

permanent relief of his pain, without removal of multiple foci of infection, is to invite disappointment, in many cases. It is true that temporary relief may be obtained by diathermia and static, as it is also true that the pain may be permanently removed by elimination of focal infection alone, but together they will shorten, vastly, the return of the patient to normal health and comfort.

The contra-indications to diathermia, are broadly speaking, two:

(1) Danger of hemorrhage.

(2) Undrained areas of pus, which, under the influence of diathermia may be absorbed, and cause a septicemia or metastatic abscess.

Static

Static electricity is a unidirectional current of an exceedingly high voltage and small amperage, self-charging, condenser discharge, generated on the surface of revolving circular, glass plates. The addition of properly connected Leyden jars increases the capacity of the static machine, and also gives you an absolute control of the frequency of the discharge or waves, which is usually 60 to 90 per minute.

The current is composed of discharges or interruptions across a gap between two brass ball terminals. The gap can be opened from one to fifteen inches, depending upon the strength of the muscular contraction you wish the patient to have. For instance, in the treatment of optic neuritis, a very small contraction or muscular vibration is desired, and in a case of lumbago or sciatica it is necessary to give a more violent massage, which is endured in perfect comfort.

In giving a static treatment, the patient is placed on a convertible, metal free chair or table on an insulated platform. An electrode of size and shape applicable to the part to be treated, is placed over the area involved and attached to the positive pole of the static machine. It is very important that the electrode is not placed over bone. When the static current is applied, the only effect felt by the patient is a local vibration, rhythmical, muscular contraction and relaxation — positively painless, if properly given. It may be likened to a sponge that has been soaked in water and suddenly squeezed.

I usually give 10 to 15 minutes of static massage to the tissues in need of such treatment, which gives the patient 900 to 1200 contraction, and relaxations per treatment. After having that particular part of the human anatomy diathermized from 40 to 60 minutes and following then, with this deep, painless, soothing massage, I think it is very easy to appreciate the beneficial therapeutic effects. Diathermia alone does help in many acute and chronic inflammations, but the addition of static massage will result in much faster benefits. In the more chronic types associated with a dense fibrosis, I believe the static to be most essential, because by its addition I have converted many of my previous failures into success. In order to appreciate the value of the static massage, you must see a patient under treatment, or have the treatment applied to yourself.

The static wave is far superior to manual massage as a follow-up after diathermia. The most delicate and finely trained human manipulation is decidedly traumatic in character when compared to the massage of a condenser discharge over the area involved. Properly applied, it can be used with benefit where any other kind of massage would only add "insult to injury." By means of this massage the acute and chronic inflammatory exudate is removed and the pathology resultant thereof.

If there is a chemical polarity change in the cells of the human body by the application of this static current, I am not in a position to state. It is the desire and aim, when passing the high frequency current and following with static massage, to correct the function of that part of the human anatomy that is being treated. From clinical experience, I feel certain that that is what is being accomplished in the following pathologic conditions:

Trauma.—In non-infested injuries, the end-results are always associated with overproduction of fibrotic tissue. The removal of this tissue is most easily accomplished by diathermia and static electricity. The percentage of permanent disability due to functional loss caused by tendon, joint and muscle injuries may be materially reduced, even in cases of long standing. If the injury is seen in the acute stage, or before connective and round cell infiltration is

marked, the recovery will be greatly hastened by the use of heat and massage, which prevent the organization of the exudate. Specific types of tissue injury, either traumatic or bacterial in origin are listed below, in all of which I have observed a sufficient number of cases to evaluate the results.

Fractures.—In fractures, after union has been accomplished, the use of diathermia and static for the restoration of normal function, where it is obstructed by excessive callus, soft ankylosis, and tendons involved in scar tissue, is indicated.

Arthritis.—After removal of causative, infective foci, arthritis, other than proliferative and deformans, is greatly benefited by diathermia and static electricity. The length of treatment will, of course, be governed by the amount of muscular atrophy and the udration of the loss of function, and may therefore be slow in its recovery to normal function.

Backache.—Chronic and acute low back pain deserves special mention, both because of its clinical frequency and excellent results obtained by the use of Physical Therapy. Except for the obvious contraindications of tuberculosis and neoplasms of the spine, backache, caused either by trauma or inflammation resulting from infection, yields to physical treatment in a most gratifying manner.

Neuritis.—Whether caused by trauma or infection, neuritic pain is almost totally caused by pressure of scar tissue and ischemia. The removal of the new tissue and restoration of the blood supply will in a very large majority of cases, relieve this condition. In cases caused by infection a permanent recovery will be rendered more likely by search for, and removal if possible, of the infecting foci.

Post-operative Abdominal Adhesions.—I am of the opinion that adhesions are productive of pain only when inflammation is present. Treatment with diathermia and static relieves this pain very quickly, and it would therefore appear that the inflammation, and not the adhesions, is removed by this treatment.

Deficient Arterial Circulation.—Obviously these conditions, which are caused by a poor arterial blood supply to the extremities, will be greatly benefited by diathermia and static. This benefit will be accomplished by nourishment of the tissues, increasing the muscle tone of the arterial coats, and partial removal of infiltration of the vessel walls.

Chronic Pelvic Inflammation and Endocervicitis.—Non-surgical pelvic inflammation, as a rule, has as its primary factor in an infection of the cervix uteri. It is, therefore, logical to include the cervix in our sphere of treatment, if a permanent recovery is to be expected. This may be easily accomplished by governing the path of the diathermia current, causing it to include the lower abdominal cavity by placing an electrode over the sacrum, and a second over the lower abdomen, followed by static massage over the lower abdomen.

Time does not permit me to give detailed and exact statement of the technical points of diathermia and static treatment, nor have I described the exact pathology. Inflammation, either acute or chronic, is the outstanding pathological feature. Both of these types of inflammation are characterized on the pressure of new tissue and inflammatory products, toward the removal of which the aim is the treatment. This removal may be best accomplished by the improvement of local circulation and thereby increasing the blood supply in order to facilitate oxidization and subsequent carrying away of these products. Diathermia followed by static massage, furnishes an ideal method of accomplishing these results as has been noted in the discussion of the pathological effects of these modalities. It is possible by increasing the circulation of the treated part, followed by massage, to bring about the reduction, if not the removal, of fibrous and round cell connective tissue pathology.

I realize that the exact histo-pathological series of change in dense fibrous tissue and inflammatory exudate are unknown. A carefully checked series of experiments on animals has not been made of the sequence of steps following the application of diathermia and static. My knowledge so far is purely clinical and empirical. But I do know that patients receive relief of symptoms caused by the clinical types listed above by means of the two agents under discussion.

There are many other pathological conditions in which it would be logical to expect diathermia and static electricity to be beneficial. I have refrained from mentioning them, or because I have not seen a sufficient number of cases on which to base accurate conclusions. I believe that in diathermia and static electricity we have at our command two potent therapeutic agents of benefit in a large variety of chronic affections. I am convinced that the future in medicine will see great strides in its application for the correction of certain abnormal conditions.

I trust that in the foregoing resumé, I have made it sufficiently clear that I do not regard Physiotherapy as a whole, as a "System" or method which replaces, in any extent surgery or specific drug therapy. Rather, to quote the late Dr. Frank Granger, "Physiotherapy forms the third leg of the medical tripod — Medicine, Surgery and Physiotherapy, and should be used with, and not against Medicine and Surgery.

It should also be remembered that Physiotherapy is not a question of one form of treatment. Just as a surgeon would find himself handicapped by having only a scalpel and a hemostat as his only instruments, so, too, will the physio-therapist find himself grieviously handicapped with only one modality to work with. This paper being confined to diathermia and static, I have not made mention of other important physical modalities used in Physiotherapy, the ultraviolet and infrared lamps, galvanic and sinusoidal current. I first practiced Physiotherapy without the static and truthfully admit I was somewhat disappointed with the results; but since having added the static machine to my armamentarium and having learned by experience to select cases, I am very much gratified with the results obtained.

Physiotherapy is not used as much as it should be because of the fact that physicians using or practicing Physiotherapy have understood very little about it and the pathology they wish to correct. Many having been unfortunate in selecting inefficient and incomplete apparatus, were consequently disappointed with the results and judged the value of Physiotherapy by their unfortunate experience.

I hope our large medical centers and universities, will give Physiotherapy a more prominent place in their teaching curriculum in order to develop scientifically trained physiotherapists. Physiotherapy is an important specialty in medicine, and from personal observation I believe it has a greater future than anything contributed by the profession in recent years. I am certain it will continue to improve if we will only develop it on a scientific basis.

Discussions

Dr. Norman E. Titus (New York City): In opening the discussion of Dr. Rueth's interesting paper, I must at the very first draw his attention to one slight error. That is attributing to Dr. Franz Nagelschmidt of Berlin the term "diathermia." Dr. Nagelschmidt improved the name of "electrothermic penetration" given to the procedure by d'Arsonval and called it "diathermy" as a shortened form of the Greek word "diathermansis." Dr. Nagelschmidt's term has been universally adopted but for some reason or other, our old friend, Major Chris. M. Sampson, coined another term, "diathermia," which is used exclusively by him and his students. We all hope that some day Dr. Sampson will get in step with the army of American physicians and drop his particular terminology. The terminology used in England is the best. The whole subject of high frequency electricity in medicine is classed as "diathermy"—either "Surgical Diathermy," "Medical Diathermy" and what is known here as "Autocondensation" is called "Couch Diathermy." Such a terminology simplifies the whole situation because in this country the difference between electrocoagulation and electrodesiccation is always a stumbling block. Wyeth created only confusion when he came out with an incorrect name which he uses in spite of lack of sanction of any organization, namely, "Endothermy." Endothermy has no place at all, is founded on a misconception of the action of the currents and is really the name of a machine originated by a company in New York and adopted for medical terminology.

I wish to second Dr. Rueth's observation that the small high frequency machines that deliver very low voltage from their terminals, cannot produce the results that a high voltage machine can. The Council on Physical Therapy of the American Medical Association will not take any stand on this question because it demands laboratory proof. However, d'Arsonval himself has told me that the only efficient source of current for proper high frequency treatments is either the Rumkoff coil or the static machine, both of which he originally used and still uses in his laboratory, in Paris. Many of us who have been using high frequency electricity for years before the Council on Physical Therapy was thought of, are all united in the opinion that the higher the voltage, the better the clinical results. Dr. deKraft of New York, who was one of the pioneers in this field in this country, is of this opinion, as is Dr. Edward C. Titus and many of the older workers in the east. In my clinics in New York I have one of

every kind of high frequency machine, except two, that are manufactured in this country. The patients do not know the difference in the machines but it is frequently reported to me that they themselves express opinions as to the smoothness of the current and the relief obtained and they ask to be treated on the larger machines rather than the small, portable ones that deliver comparatively low voltage.

Dr. Rueth mentions the factor of resistance with the high frequency current, saying that the higher the resistance, the greater the heat generated. This is in general true, but it should be brought to attention that in treating the human body, we must consider the difference between the transmission of the current through tissues of varying resistance. The factor of the hook-up plays an important part. In other words, if the current passes through tissues of high and low resistances in series, the greatest heat is generated in the tissue of high resistance. If, however, the hook-up or arrangement is so that there is a choice allowed to the current to pass in parallel through either tissue of high or low resistance, then the greater heat is generated in the tissue of low resistance. As an example, giving diathermy laterally through the thigh, very little, if any, heat is generated in the bone because the current can pass around the bone through the tissue of much less resistance and consequently very little, if any, current goes through the bone itself and the heat generated is in the peri-osseous tissue. Too many men forget this peculiarity of electricity and for that reason I present it for your attention.

Further on in the paper it is stated that "It is very important that the (static) electrode is not placed over bone." In this I cannot agree with the writer because in such cases as arthritis of the sacroiliac joint or of the spine, it is necessary and correct to place the electrode over the bone directly so that the decongesting effect of the static current can act upon the extraneous material deposited in and around the joint.

I must take exception to Dr. Rueth's over-reaching the present day knowledge a little bit when he states that static "used in a proper manner gently produces a mass molecular, an atomic and even an electronic vibratory massage." The whole action of the static current, as we know today, is based on the decongesting effect it produces due to its high voltage and low amperage. We may some day find out that the static current causes some sort of infinitesimal molecular action, such as vibration. However, one of the factors that has dissuaded many men from taking up the static current is that Snow and so many of the older workers, without real scientific knowledge, have credited the current with so many mythical qualities, such as the remarks I take issue with in this paper.

This paper, of course, is restricted to diathermy and static and the paragraph concerning the treatment of fractures is well within the usefulness of these two agencies, but it should be remembered that in recent fractures, where there is swelling of the part, in fact before and after the reduction of many fractures, static has a definite place in removing the excess fluid in the tissues and reducing the local swelling, thus making reduction easier and alleviating the pain caused by additional trauma after the fracture has been reduced. At the Medical Center, in New York, all dislocations and fractures of small bones are given the static brush discharge both before and after the immediate surgical treatment and, if there is great swelling, the static brush discharge is applied daily with the cast removed and then replaced until the next treatment. It is also worth drawing attention to the fact that fibrous ankylosis, such as of the fingers, resulting from disuse during the active treatment of the fracture, can be broken up and actually traumatized by passive motion, and then if this is followed with the static brush discharge, the immediate effects of the trauma can be overcome and the patient will not have such pain as he would have had if the static was not applied. I want to mention that contrary to the experience of a great many and the belief of many more who have not had the experience but are prone to be over-enthusiastic about diathermy, I have never observed any distinctly beneficial effect from diathermy when used to decrease the time of fracture union. Others may have had great success but such has not been our experience in New York.

Inasmuch as there has been so much published regarding the effect of diathermy and static on abdominal adhesions, I would suggest that the writer go into exact detail regarding the successful technic he uses. The literature on physical therapy is very indefinite about exact procedures in technic and should it be the desire of some doctors to treat abdominal adhesions, the writer of this paper can help these men very definitely if he will describe his successful technic in detail.

In the treatment of chronic pelvic inflammation, experience has shown that two external electrodes do not work as well as a vaginal electrode, combined with one on the surface. Where there is a specific infection the technic originated by Cumberbatch is phenomenally successful. It is based on the fact that even though the most prominent source of infection is in the cervix, as is well understood, correct treatment should include the use of diathermy in the urethra, where many organisms are sequestered in Skene's glands.

There are two particular uses of the static current which are worth emphasizing, and that is its wonderful effect on congestive, so-called hypertrophied prostates and retroversion in young girls. If there is infection of the prostate, diathermy given with a rectal and abdominal electrode through the prostate, is of great help. In cases that are not infected, the rectal administration of the static wave current brings very great symptomatic and anatomical relief. In dysmenorrhea, caused by retroversion in young girls, similar application of the static wave current with a rectal electrode increases the turgidity of the uterus and quite consistently causes it to assume its natural position with great relief of pain. This effect can also be achieved in subinvolution, where the effect of the current on the uterus causes it to involute very quickly.

The static brush discharge, following diathermy, has a great beneficial effect upon varicose ulcers, relieving the pain caused by poor circulation and congestion. The ultraviolet light generated by the static brush discharge stimulate the

ulcer and increase the speed with which it heals. It is one of the most gratifying procedures in physical therapy to treat varicose ulcers because of the immediate relief given to the patients.

As a matter of record I might mention that the use of diathermy and static brush discharge on the eye for the treatment of cataracts is being studied in the Department of Physical Therapy of Columbia University and the results so far lead to hope that the treatment may be established after further research.

Dr. Rueth mentions that improvement in technic and equipment should be striven for. It is of course worthy of us all to hope for improvement in equipment but as far as the static machine goes such is rather improbable. The present Toeppler-Holtz machine used was designed in 1836 and all attempts at improving it have been unsuccessful. It would be advantageous to have a smaller, less expensive machine to do the work, but so far electrical engineers have been unable to make one. It must be remembered that the static current is the original electric current, having been described as early as 1600. Because the current was generated by friction, using amber, which in Greek is called "electron," William Gilbert coined the word "electricity" for the force created by friction of amber and cloth. Therefore, we can say static electricity is the parent of all electrotherapeutics and it is gratifying to note the gradual increase in interest taken in its rational use in therapy. It has been such a spectacular agent that in the past it has been used largely for psychotherapy, and few men have attempted to really study the current to find out what it is worth. Static machines created the x-ray in the first tubes used and the static machine was the original machine, as mentioned above, used by d'Arsonval to create high frequency currents. Therefore it is fitting that a revival of the parent of all electrotherapy should be watched with satisfaction amongst serious workers in physical therapy, and I tender my personal thanks to Dr. Rueth for his paper, as well as for the privilege of endorsing his ideas of the great efficiency of static electricity.

Dr. J. E. Rueth (Milwaukee), closing discussion: Dr. Titus opening remarks concerning the correct spelling of "diathermy" rather than "diathermia" are very interesting. As I have been a student and close follower of Dr. Chris. Sampson's physio-therapy technique, no doubt I have adhered as closely to his terminology "diathermia."

I do not place static electrode over bone, as Dr. Titus suggests is the correct method, because of the pain experienced by patients. Complete decongestion can be obtained without pain by placing the electrode over muscles adjacent to part being treated.

It is very gratifying to me that Dr. Titus opinion agrees with mine concerning the greater value and importance of high voltage diathermia, as well as the imperative necessity in most cases, of following diathermia with static. I really feel the higher the voltage the better the results that I have had with patients. I think it is perfectly logical when you find a highly resistant body (as for instance arthritic knees that are very much enlarged) that it should be more effective to have a real high voltage, and that the current should be more sedative. It is interesting for me to hear that Dr. Titus' clinical experience coincides with mine in that he states his patients can feel immediately the difference between a low and a high voltage machine. This experience caused me to discard low voltage machines a number of years ago and to use high voltage machines exclusively.

In regard to Dr. Titus' vigorous objection to my speculative assumption regarding "electronic massage" following the use of static electricity, this speculation is in keeping with the thoughts of modern physicists. High voltage electricity has been demonstrated to provoke disruptions in the molecule and atom, according to the workers at the California School of Technology, the head of which is Millikan, himself. It has even been demonstrated that the very atom is not immune. It is time now that Physical Therapy study the action of its agents on a basis of its physico-chemical effects rather than theorize regarding its clinical effect. I agree with Dr. Titus that all of studies must be meticulously checked by means of more scientific controls and based upon more fundamental knowledge. To this end I join with Dr. Titus in a plea for more scientific physical therapy.

Vitamin D Now Produced in Crystal Form

According to latest announcements, Prof. Adolf Windous, Nobel prize winner in chemistry in 1927 and 1928 has succeeded after four years of experimentation with the mysteries of vitamin D substance in producing this substance in pure crystalline form. This antirachitic substance can now be supplied by means of direct irradiation through ultraviolet sources (natural and artificial) as well as through irradiation of foods and sterols. Vitamin D occurs rather infrequently in foods, the principal sources being fish, liver oils, and the body fats of some fishes. It is also present in milk, butter and cheese.

ESTABLISHED ACTINOTHERAPEUTIC MODALITIES IN DERMATOLOGY *

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The scientific irradiation of skin diseases, notably the use of the two leading modalities, x-ray and ultraviolet ray, while hardly over two decades old, has gradually reached the level of a universally accepted and recognized method of treatment.

It assumes an ever-increasing importance, particularly in the case of the ultraviolet light, due to the fact that the persistent and persuasive commercial literature, extolling the magic therapeutic results of the actinotherapeutic appliances induces ever-growing numbers of practitioners, both regular and irregular, to invest in such appliances.

Yet, in spite of the tremendous increase in the number of clinicians using actinotherapy in various dermatoses, there is considerable confusion and uncertainty in regard to the clinical indications, the dosage and various details of technic, both in x-ray and ultraviolet light. This state of affairs was well recognized and voiced in a recent editorial of the *American Journal of Physical Therapy.*

For this reason it seems timely to attempt the analysis of these agencies from the clinical dermatologic point of view, to establish their clinical indications, their respective virtues and limitations, and finally to emphasize some fundamental therapeutic principles forming the basis of the successful and rational use of these modalities.

Mechanistic Versus Biologic Principle in Physiotherapy

First I wish to re-emphasize the basic principle underlying all rational therapeutics and most strikingly demonstrable in the physiotherapy of skin lesions, i. e., to treat not only the individual lesion itself, but the skin disease as a whole, and still more than this, the patient as a single biologic unit.

As a result of the commercially inspired enthusiasm of the literature flooding the offices of the general profession, and the lack of guidance and information from the responsible and competent clinicians, the mechanistic conception of physiotherapy is permeating the rank and file of the profession. The mechanical perfection and efficiency of physiotherapeutic appliances, the quartz lamp, carbon arc, or x-ray transformer, are over-emphasized and stressed as the chief controlling factor of successful therapeutics, and are exalted far above the sound clinical judgment, diagnostic acumen, or therapeutic skill.

The conception of skin diseases is simplified and reduced to the status of local lesions which irrespective of their etiology and pathogenesis will melt away under local actinotherapeutic applications if carried out according to the instructions and directions of the manufacturers.

Unless the physiotherapeutic education of the general profession is taken out of the hands of the commercial interests, the mechanistic viewpoint will completely debauch and disintegrate physiotherapy as a branch of clinical medicine and will reduce the physiotherapeutist to the degree of physiotherapeutic technician, devoid of clinical competence and intelligence, and will push back for decades the progress and practice of scientific physiotherapy in skin diseases.

A therapeutic principle so simple and self-evident as to be considered a truism should be adopted as a basis of physiotherapeutic endeavor in dermatology. *No clinician is qualified to use any physiotherapeutic agencies in the treatment of skin diseases unless he is competent to make intelligent interpretation of the skin lesions, to effect a correct dermatologic diagnosis, and capable of using other dermatologic methods of treatment.*

An elementary grounding in diagnostic and therapeutic dermatologic technic is a much more important qualification for a physiother-

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, October 7, 1931.

apeutist treating skin diseases than the mere technical and mechanical knowledge of physiotherapeutic appliances which can be mastered by a technician or a nurse.

Ultraviolet Light

Ultraviolet light is unquestionably the most widely used actinic agent in skin diseases. Yet it has the least established and the most controversial therapeutic rating. Magnified and glorified, as a panacea for all human ills, by the commercial literature on the one hand, and frowned upon and deprecated by many representative dermatologists of this country (Fox, Highman, McKee, Wise, Zeisler) on the other, ultraviolet light stands as a therapeutic enigma and mystifier. A detailed clinical evaluation of it can be properly preceded by the consideration of its biochemical and clinical properties.

Air and Water Cooled Burners

Theoretically, according to Pacini, there is considerable difference in the biochemical properties of air and water cooled burners. Clinically such difference can hardly be appreciated. Because of the larger aperture air cooled burners are used preferentially for systemic radiation. Because of the larger size of the mercury arc, the air-cooled burner apparently produces a more intense radiation.

The method of pressure therapy with a quartz lens to the skin lesions directly has not come up to all expectations and has proved rather disappointing. The assumption was that through a temporary ahematization of the skin by the pressure of the quartz lens a deeper penetration of the ultraviolet rays might be obtained. This has not been born out by clinical experience. Only the superficial destruction of the upper layers of the epidermis with a subsequent desquamation has been accomplished. In my experience the pressure therapy has a very limited field of usefulness in a few dermatologic conditions, such as chloasma, small patches of psoriasis, superficial senile keratoses and gold resistant discoid type of lupus erythematosus.

Carbon Arc Burners

It is important to remember that ultraviolet rays can also be obtained from carbon arc burners. Many practitioners seem to be unaware that a carbon arc burner of the modern impregnated metal cored carbon type possesses a powerful actinic action, and can duplicate all desirable clinical effects produced by quartz burners. The detailed discussion of the comparative value of carbon arc and quartz lamps was offered in my earlier contribution. At this time I shall merely restate the salient points and conclusions:

1. Carbon arc emits ultraviolet rays of actinic potency, less intense than the shortest waves of the quartz lamp, yet amply sufficient for dermatologic therapeutic purposes.
2. Carbon arc and quartz cover practically the same field of clinical indications, and with a few exceptions can be substituted one for the other.
3. Carbon arc is to be preferred in dermatoses with a systemic background.
4. Carbon arc presents several technical and practical advantages over the quartz lamp.

Carbon arc is a therapeutic agency of equal value with the quartz lamp, and is undeservedly ignored by dermatologists.

Actinic and Clinical Properties of X-Ray and Ultraviolet Light

Ultraviolet light and x-ray are the two most widely used (and rivaling in popularity) actinic agencies in the treatment of skin diseases. The therapeutic potency of x-ray is so well established that it requires no further argumentation or exposition. In fact, the excessive use and abuse of x-ray constitutes the outstanding problem of dermatologic physiotherapy today. The magic of its therapeutic power lures the would-be dermatologist who happens to own an x-ray transformer into the indiscriminate use of it in a host of dermatologic conditions which could be controlled as well or better by other means. To clarify the clinical indications of x-ray and to sketch the relative therapeutic values of x-ray and ultraviolet light is the chief purpose of this contribution.

To make this presentation more effective and concrete I prefer to compare their relative effectiveness in obtaining the major therapeutic effects sought for in dermatologic practice. These effects are:

1. Bactericidal.
2. Antipruritic.
3. Stimulating and Regenerative.
4. Absorptive.
5. Inhibitive and Destructive.

It is important to state at the outset that the chief therapeutic limitation of the ultraviolet light is the superficiality of its local ac-

tion on the skin. This at once determines that its greatest clinical usefulness lies in the field of superficial dermatoses. This also explains the numerous failures of the ultraviolet light in infiltrating dermatoses and granulomata. As was the case with other therapeutic agencies, the failures were credited to the agency, while actually they were due to the indiscriminate and irrational selection of cases

Bactericidal Effect

The bactericidal property of the ultraviolet light has been demonstrated *in vitro* by Pacini, McCaskey, Brown and Russ, Coblenz, and others. However, *in vivo* demonstration of this bactericidal effect was not successful because of the extreme superficiality of its action.

The local radiation with ultraviolet ray alone can clear up only the most superficial bacterial and mycotic dermatoses, such as tinea versicolor, pityriasis rosea, tinea circinata, and pyodermata.

Because of the superficial action of the ultraviolet ray the technical detail of the thorough cleansing of scales, crusts, pathologic deposits, and ointments assumes major importance for the purposes of effective radiation.

However, the systemic effect of the ultraviolet ray on the immunity-raising mechanism is so marked that its therapeutic value, even in local bacterial dermatoses, is at least equal to, if not greater than, its local bactericidal properties. This has been strikingly demonstrated in clinical experimentation by E. Hoffman, who repeatedly succeeded in clearing up lesions of lupus vulgaris by systemic radiations alone, with a complete exclusion of the affected areas from the radiation.

In view of this it is biologically sound and clinically effective to use a combined local and systemic radiation of the ultraviolet ray in a large group of bacterial and mycotic dermatoses such as furunculosis, impetiginous eczemas, infectious eczematoid dermatitis, seborrhoic eczema, epidermophytosis, and various types of tuberculides.

Only deep infiltrating mycotic granulomata, such as blastomycosis, actinomycosis, etc., are beyond the therapeutic reach of the ultraviolet ray and are better treated by x-ray. X-ray has no direct bactericidal effect, yet it is of great clinical usefulness in many bacterial and mycotic dermatoses, as it seems to possess some alternative effect on the tissues, producing an inhibitive effect on the bacteria and fungi. Furthermore, its clinical usefulness is enhanced by its specific property to absorb infiltrates and induce an epilation. This renders the x-ray the remedy of choice in bacterial mycotic dermatoses with secondary eczematous infiltration, in deep mycotic granulomata and mycotic injections of the hair follicles, such as staphylogenous and hyphogenous sycosis of the scalp and beard.

Antipruritic Effect

The antipruritic property of the ultraviolet ray has been established empyrically by a large number of clinicians. The exact mechanism of this effect is not explained so far, and is probably due to the biochemical action on nerve endings. The superficiality of the action of the ultraviolet ray limits the clinical value of its antipruritic effect and renders it inferior to that of x-ray, both in the depth of penetration and the duration of the effect.

In considering the antipruritic effect of the ultraviolet ray it is important to keep in mind that itching is merely a symptom caused in different dermatologic conditions by different pathogenic factors. Thus, in acute inflammatory dermatoses itching is due to the irritation of cutaneous nerve endings by the edema and engorged blood capillaries, and is relieved by simple cooling, antiphlogistic and protective applications. (Physiotherapy in these types of cases is not only superfluous but actually injurious.)

In subacute and chronic dermatoses itching is caused by the pressure of the cellular infiltration and is relieved by absorptive and biochemically stimulant medication or physiotherapeutic measures much more than by antipruritic measures as such.

Furthermore, in pruritic dermatoses caused by animal, bacterial, or mycotic parasites, the rational control of pruritus is obtained only by antiparasitic and antiseptic local applications. In this group of cases only those physiotherapeutic measures are permissible and advisable which also possess bactericidal and fungicidal properties. Ultraviolet ray happily presents such combined effect, and therefore is of great clinical usefulness in this class of cases.

In cases of systemic pruritus such as observed in diabetes, liver diseases, leukaemia, nephritis, etc., the rational treatment is ob-

tained by the control and elimination of the toxic products and systemic pathology. The local symptomatic treatment is of minor importance. In this group of cases ultraviolet ray is much to be preferred because of the technical ease of general irradiation, greater safety, and the tonic stimulating effect on general metabolism. In this group of cases must also be placed the so-called essential pruritus observed in neurotic individuals, winter pruritus, bath pruritus, hypothyroid and senile pruritus. On the other hand, in localized pruritic lesions associated with deep and dense inflammatory infiltration, such as in lichenoid eczemas, neurodermite, lichen planus plaques, x-ray is much superior.

Stimulating and Regenerative Effect

This property of biochemical tissue stimulation and vitalization is the most valued effect from the clinical point of view. It is the basis of all clinical utilization of the ultraviolet light in clinical medicine. Various systemic biochemical effects of the ultraviolet ray are expounded and vaunted in numberless papers.

The most authoritative and exhaustive review with a complete bibliography can be found in the article by Meyer.

According to many experimentors and observers ultraviolet light profoundly affects general metabolism, particularly that of calcium. It activates cholesterin, increases the bactericidal properties of the blood and raises the general immunity of the body to infection. It increases assimilation of iron, possesses strong antirachitic action, and raises the general vitality.

That ultraviolet ray, besides the systemic effects, possesses a marked local vitalizing and regenerative tissue effect is strikingly illustrated by its well known healing power in sluggish asthenic ulcerations, x-ray ulcers included. This local and systemic property of tissue vitalization readily explains the great clinical usefulness of the ultraviolet ray in the group of subacute and chronic localized and generalized inflammatory dermatoses. In contradistinction to this, x-ray has no systemic regenerative or stimulating effects on the tissues. Its effects are essentially cell inhibitive, absorptive and destructive.

This group includes a large bulk of dermatologic material comprising dietetic, toxic, metabolic eczemas, seborrhoic dermatitis, generalized pyogenic and mycotic dermatoses, generalized psoriasis, lichen planus, and dermatitis herpetiformis.

In cases of this type I consider ultraviolet ray of greater clinical utility than x-ray in spite of the spectacular capacity of x-ray to clear up individual lesions.

To depend on x-ray exclusively in generalized dermatoses is an irrational and extravagant expenditure of time and effort not commensurate with ultimate clinical results. The exclusive use of x-ray is particularly objectionable in dermatoses prone to recurrences, such as psoriasis, dermatitis herpetiformis, and systemic and mycotic eczemas. It is these cases that lead an x-ray enthusiast beyond the limits of safety to a late appearance of degenerative changes of the skin.

Absorptive and Destructive Effects

One of the important clinical effects sought for in dermatologic practice is that of absorption and destruction of various pathologic lesions. Generally this effect is desired in deep infiltrating dermatoses, mycotic or specific granulomata, and benign or malignant tumors.

Ultraviolet ray has no capacity of absorption, and its destructive capacity is limited to horny epidermis manifested by superficial desquamation. Obviously then, no results can be expected from its local effects in deep infiltrating skin conditions. X-ray and radium reign here supreme.

Technique and Dosage of the Ultraviolet Ray

One of the basic factors of physiotherapeutic technic is the dosage. It is the tendency of modern physiotherapeutic research to introduce instead of the biologic units such as erythema or fractions thereof, the dosage based on precise, physically measured units. However, as it was pointed out by Coblenz, the technical difficulties and mechanical complexities involved render such contrivances out of the reach of the average clinician. Hence the prevalent method of measuring is still by erythema units.

Perusing medical literature on the subject, one is likely to get the impression that erythema of various degrees is the condition *sine qua non* for any therapeutic effect. Commercial circulars are particularly insistent in this claim. In fact, the capacity of the burner to produce an intense erythema in the shortest possible time is one of the strongest selling points which induce the guileless practitioner to acquire an ultraviolet lamp. As a result of

this crusade of the intense reactions, countless skins are erythematized, peeled, and blistered without benefit, and often with distinct aggravation of the skin lesions.

My personal experience of over ten years with actinotherapy leads me to believe that erythema reactions, much less blistering, are advisable and permissible only in the small minority of dermatologic conditions. *It is my belief that the major dermatologic effects of ultraviolet ray, such as bactericidal, antipruritic, stimulating, and regenerative, are readily obtained with repeated small fractional doses, with greater safety and greater comfort to the patient.*

In all subacute and exudative dermatoses, whether localized or generalized, fractional doses are the only ones permissible. Intense erythema doses are distinctly harmful in this group of cases.

Intense erythema or blistering are indicated only in a small number of dermatoses, in which a peeling effect is desired, such as chronic psoriasis, sluggish, dry, scaly dermatomycoses, alopecia areata, chloasmata, or gold resistant discoid patches of lupus erythematosus.

Moreover, the technic of fractional doses is more in accord with the basic therapeutic principle of natural actinotherapy by sunlight, all the beneficial and vitalizing effects of which are obtained by repeated systemic exposures. The clinical value of the erythema reaction is over-rated, far beyond its actual value.

Synergism and Antagonism Between Ultraviolet Light and X-Ray

One of the most interesting questions of physiotherapy, both from a theoretical and practical point of view, is that of synergy and antagonism between x-ray and ultraviolet ray. The origin of the idea of the possibility of the synergistic action of the ultraviolet ray and x-ray can be easily traced to the empyrically observed antithesis of the biochemical effects of the two agencies on living cells and the organism.

The dominant biochemical effect of the ultraviolet ray is cell stimulating, regenerative, reconstructive—in more empyrical terms—tonic and vitalizing.

The dominating biochemical effect of x-ray acting on the living cell through the profound changes in the nucleus of the cell, is inhibitive and destructive.

The concrete epitome of this biochemical antithesis is seen best in the healing of the asthenic ulcers under ultraviolet ray, and in the devitalizing effect of the x-ray on the young embrional cells, such as those of testicles and ovaries. (This destructive property of x-ray is utilized in the treatment of malignant tumors.)

These clinically observed facts gave rise to an assumption that ultraviolet ray might be utilized to neutralize the degenerative effect of massive doses of x-ray.

It was Sampson[12] who brought out this idea in an iconoclastic manner and has advanced the extreme claim that very large, intense erythema reactions of the ultraviolet ray may neutralize and counteract massive doses of x-ray and prevent second and third degrees of x-ray burn. McKee has decisively refuted these claims in a series of clinical experiments.

McKee's conclusions merit some supplementary interpretation, since taken at their face value they might lead to wrong conclusions. McKee did prove that massive doses of ultraviolet ray cannot stop nor prevent the effects of massive doses of x-ray. That much could be predicated on theoretical grounds alone. How can a therapeutic agency which penetrates a depth of one millimeter or less neutralize or prevent the effect of an agency which penetrates 5-15 millimeters or more?

Furthermore, it is hardly biologically rational to expect a regenerative effect from blistering doses of the ultraviolet ray. These doses can produce only the destruction of superficial layers of epidermis and through a superimposed irritation intensify the effect of the x-ray. As emphasized above, regenerative effects can be expected more from repeated fractional doses of ultraviolet ray gradually increased to a degree of mild erythema.

McKee himself, in his discussion of the treatment of the x-ray ulcers, endorses the technic of small doses of ultraviolet ray. He thus admits at least a partial curative and neutralizing effect of the ultraviolet ray. Beneficial effects of the ultraviolet ray in the treatment of x-ray teleangiectases are reported by Axman, Hazen, Lane, Rulison, and others. Hence the phenomenon of partial biochemical antagonism between ultraviolet ray and x-ray must be admitted, and to this extent the original claim of Sampson is justified.

The clinical feeling of this partial antag-

onism prompted me many years ago to utilize this phenomenon in therapeutics. However, my reasoning and technic were quite different from Sampson's.

My assumption was that by combining and alternating fractional doses of ultraviolet ray and fractional doses of x-ray the same therapeutic effect could be obtained with a smaller amount of x-ray. It is assumed by radiologists that on the skin sensitized by the ultraviolet ray, a dose of x-ray produces a stronger effect than it would on the non-sensitized skin; in other words, the same therapeutic effect can be obtained on the sensitized skin with a smaller dose of x-ray. On the other hand, the safety of the procedure is secured, both by the small dosage of x-ray and the partial neutralization by the ultraviolet ray. The doses of x-ray used are one-eighth, one-sixth, and one-fourth of the skin unit. Ultraviolet ray dosage is always below erythema dose. The treatments are usually given either alternately spaced three or four days between, or two ultraviolet ray treatments in succession and one x-ray.

This technic was applied by me over a period of ten years in several thousand localized and generalized dermatoses of various types, such as eczemas, toxic, mycotic, or bacterial, lichen planus, and dermatitis herpetiformis, with highly satisfying results. (In acne I use ultraviolet ray only in mild and incipient cases; in more severe cases I use it only after the full series of x-ray treatments is given.) I can emphatically state that in these many years I have never had a case of an acute, delayed, or chronic x-ray degenerative sequelae. I consider this combined treatment, both rational and effective, as it reduces the amount of x-ray given by substituting and supplementing a more superficial but safer actinic modality. Possibly other clinicians use this method with some variations in their work. However, neither McKee in his manual, nor textbooks on dermatology mention this desirable mode of procedure and technic.

X-Ray

The remarkable power and penetration of the actinic effects of x-ray on the skin has rendered it the supreme therapeutic weapon in dermatology. Through the law of paradoxic relationship the very same therapeutic power of x-ray makes it a dreaded remedy, potential of permanent, irreparable damage. Relying on the mere therapeutic efficiency of x-ray, thousands of practitioners without any training in dermatologic diagnosis or treatment use x-ray indiscriminately in any skin condition which defies simple local applications. The primary object becomes the clearing up of the skin lesion, without any attempt to establish diagnosis or search of a rational, etiologic treatment, or instituting appropriate systemic measures.

Even assuming that every skin lesion is cleared up without subsequent damage to the skin, the mere symptomatic clearing up of the lesion is irrational and undesirable, as it degrades what might be the highest form of therapeutic intelligence into a mere technical procedure which can be carried out by a technician or a nurse.

Actual conditions are infinitely below this hypothetical optimum. In many cases the lesions prove resistant to x-ray, and the clinician persists in radiation until he exceeds the limits of safety. In many other cases lesions recur, and x-ray radiation is repeated until cumulative actinic effects bring out chronic degenerative x-ray changes in the skin. The actual figures of x-ray burns of various degrees of severity produced in dermatologic conditions in this country can never be estimated, but it is a conservative statement that it runs into many hundreds annually. There is only one way to remedy this deplorable condition, that is to impress the profession with the grave responsibilities attached to the use of x-ray in skin diseases. May I be permitted to quote a few statements bearing on this point from my earlier contribution on the subject.

"It should be a clinical axiom that *x-ray is to be reserved only for deep and resistant lesions, as a means of last resort, never as the first choice.*" Neither x-ray nor ultraviolet ray should be used as a sole therapeutic agency. They should be supplemented by appropriate local and systemic therapeusis. In fact, no clinician is qualified to use x-ray in skin diseases unless he is also capable and competent to use other dermatologic measures. A grounding in dermatologic diagnosis and therapeutic technic is a much more important qualification for a clinician who uses x-ray in skin lesions than mere technical knowledge of x-ray apparatus.

Hence it is nothing but fair to demand that any practitioner who intends to use x-ray in

skin lesions should take post-graduate courses in dermatologic diagnosis and treatment.

A principle that should be indelibly impressed upon the mind of every physiotherapeutist is that the *therapeutic skill of using x-ray in skin lesions is measured by the smallest amount of x-ray used in obtaining the desirable therapeutic results.*

X-Ray Dosage

The chief factor of safety in actinotherapy is the exact appropriate dosage. The problem of dosage in x-ray is still an unsettled and controversial issue.

In this country dermatologists have universally adopted the method of indirect measurement elaborated and expounded by McKee. This method after a clinical trial of more than a decade, proved to be eminently successful and practically safe for all clinical purposes.

Yet there was a growing demand on the part of the physicists and radiologists for a more exact physical unit of measurement because of the variations in the perception of erythema by different clinicians and still more so because of the great variability of the x-ray output by different Coolidge tubes and x-ray transformers, as was experimentally demonstrated by Glassman and Portman. The additional motive to search for such a physical unit was the practical inability to duplicate under the present technic, dosage of various clinicians.

Finally, such a unit based on the ionization quotient has been worked out and internationally adopted as the x-ray standard unit, known as the R unit. In spite of its exactness from a physical point of view, the R unit has not been adopted by dermatologists of this country. The reasons for this are readily found. The clinician is primarily interested in the biologic effects of his dosage and he can use R units only so far as he can express and measure in these units the biologic effects of erythema and its fractions. The clinician can use R units only as a check up as to the stability of his apparatus and tube. But, as mentioned above, McKee's indirect method of measurement has proven so safe and reliable as to render the R unit a theoretical luxury rather than a practical necessity. Besides, technical complexities of the procedure make it a practical impossibility for use in daily practice.

To discuss the inherent sources of errors in the ionization method is beyond my competence. A question, however, may be raised whether the ionization quotient of x-ray does exactly correspond to the biochemical actinic property of x-ray. To quote A. Soiland, one of the pioneer radiologists of this country: "Under the present conditions the ionization method of measuring x-ray is perhaps the most accurate method we have. Nevertheless, it is extremely unsatisfactory. The hardest x-ray and gamma radium rays may give the same ionization values and still they produce different results clinically. No amount of research along purely physical lines will solve problems applicable to biology and physiology. Biologic research and clinical experience must do it for us."

This point of view lends support to my own personal feeling in the matter that the clinical value of mechanically standardized and physically precise dosage is much overrated. There is a biologic factor of deep clinical significance to be considered. It is an impossibility for any mechanically perfect and physically precise unit of measurement to specify the exact amount of actinic energy necessary for any individual case. No amount of mechanical perfection and precision in the equipment and dosage will ever solve alone the problem of therapeusis and relieve the clinician from the responsibility of using his clinical judgment in gauging correctly the clinical reactions from a given treatment and evaluating on a purely clinical basis the dosage and frequency of actinic radiation to be given. This constitutes the element of art in clinical medicine which can not be supplied by mechanical means.

From this point of view the modern tendency to standardize physiotherapeutic treatments for individual cases and reduce them to mathematical and mechanical formulas is to be deprecated. The *standards of dosage can be accepted only as the average or mean dosage changeable by the clinician to suit the requirements of an individual case.*

Empyrical Dosage of X-Ray in Dermatology

In discussing the prevailing technic and dosage of x-ray therapy in dermatology one general statement can be made. The most common technical error from a dermatologic point of view is overtreatment and excessive use of x-ray. It is used in many more cases than it is indicated or necessary, and in greater quantity and quality of ray than neces-

sary. In a general way x-ray is indicated in localized deep infiltrating dermatoses and granulomata, and benign and malignant tumors. Generalization and still more universal dissemination of the skin eruption is by itself a contra-indication for the use of x-ray. In these cases x-ray is permissible only in a few selected areas and should always be subordinated to systemic treatment and regimé.

It is good to remember the statement by McKee, unquestionably the most authoritative x-ray therapeutist in dermatology: *"X-ray produces permanent cures in a relatively small number of skin diseases.* It is a mistake to depend too much on this modality."

A large number of superficial inflammatory dermatoses can be cured without x-ray, and a still larger group of cases can be cured only with incidental and casual x-ray radiation.

As to the average dosage, the overwhelming majority of inflammatory dermatoses respond to one-sixth and one-fourth skin unit doses weekly. Only lichenoid, sclerotic, and verrucous dermatoses and deep granulomata call for large doses, such as one-half and three-fourths skin units. Malignancy and scalp epilation call for a single massive dose. As to the quality of x-ray used, I believe that the voltage commonly used, particularly by radiologists, is far above the necessary limits. I find a five-inch spark gap (88 kilovolts) perfectly sufficient in a majority of inflammatory dermatoses, including acne. In more superficial dermatoses, in children, and in the regions covering radiosensitive organs, such as eyes, breasts, and testicles, I use as little as three- to four-inch spark gap (64 to 76 kilovolts). Only in malignancy and deep granulomata is a six-inch spark gap (100 kilovolts) used.

As to the filtration, my favorite filter in the average case, including acne, is one-fourth millimeter of aluminum. In very superficial dermatoses and in young children I use no filter. I see no reason for heavy filtration in dermatologic conditions, yet it is not uncommon to see radiologists use three millimeter of aluminum and one millimeter of copper with correspondingly increased voltage to the tremendous figure of 200 kilovolts.

From a dermatologic point of view it is hard to understand the rationale and justification for the use of a ray of such penetration. As is formulated by the Draper-Grothus law, only those rays produce actinic effects which are absorbed by the tissues.

Histopathologic studies have definitely shown that even x-ray of such low voltage as grenz rays (ten kilovolts) produce degenerative changes to the full depth of the true cutis. In other words, in radiation with high voltage a large percentage of hard rays is absorbed by underlying tissues which are far below the level of pathology observed in common dermatoses, and actinic effects on the skin lesions are obtained by the tremendous increase of the amperage which supplies a sufficient quota of soft rays to produce superficial actinic effects.

That the rays of high penetration are wasted in the underlying tissues and produce there unintended actinic effects was strikingly illustrated in the experimental work of Bachem, who, working with two to four millimeters of aluminum filter, produced erythema on the opposite side of the limb, down through the muscular tissue and bones. Deep filtration should be reserved only for deep hypodermic infiltrating conditions. The bulk of ordinary dermatologic material requires no filtration or a very light one, such as one-fourth of a millimeter of aluminum. As McKee correctly states, the quantity of x-ray is a much more important factor in the safety and production of clinical actinic effects than the quality of the ray.

Ultraviolet Ray Versus X-Ray

One of the important practical issues in modern dermatologic physiotherapeutic is the relative therapeutic evaluation of x-ray and ultraviolet light, and their respective clinical indications.

It is of interest that while European observers highly esteem the therapeutic value of ultraviolet ray in dermatology, many representative American dermatologists frown upon and deprecate its clinical usefulness. Fox, McKee, Highman, Wise, and Zeisler and others seem to be disappointed in the therapeutic effects of the ultraviolet light in various dermatoses, essentially because they compare the effectiveness of the ultraviolet ray with x-ray in the capacity of clearing up deep infiltrating skin lesions.

Such evaluation seems to be unfair to both agencies and seems to be missing an important principle of the evaluation of dermatologic therapeutic methods. In no other field of

clinical medicine is a difference drawn so concretely between an external manifestation and its underlying systemic condition, as in dermatology. In other words the therapeutic evaluation of a modality capable of clearing up a cutaneous lesion will depend entirely upon whether this lesion is purely local or systemic in origin. In the first case its efficiency will be graded 100 per cent, in the second, only a fraction of that, and then it must be supplemented by various systemic measures to control the etiologic factor; otherwise the lesion is sure to recur or even a temporary clearing up of the lesion is likely to be considerably prolonged. From this point of view a therapeutic modality may not possess a strong local therapeutic action and yet be extremely useful through its systemic, tonic or alterative effects. This is particularly true in the case of the ultraviolet ray. The indirect curative value of the systemic biochemical properties of the ultraviolet light on the skin lesions in various dermatoses has been reported by a large number of clinicians.

The classical demonstration of it has been supplied by Bruno Bloch and Jesioneck who repeatedly cleared up by systemic radiations alone, lesions of lupus vulgaris (the local radiation was deliberately excluded). This being the case, *the ultraviolet light would be a valuable therapeutic agency in a large variety of localized dermatoses and, more so in systemic, even if it did not possess any local actinic effect on the skin.* The additional capacity of the local actinic action, even though superficial, enhances and strengthens the therapeutic value of the ultraviolet light in dermatology.

In view of these facts the statement that ultraviolet ray is of very limited utility in the treatment of skin diseases appears dogmatic, not in accord with biologic therapeutic principles, and not in accord with the clinical experiences of many reliable observers.

Furthermore, it is hardly rational to compare x-ray and ultraviolet ray on the basis of one arbitrarily selected therapeutic property, as these two modalities differ radically in their general biochemical properties. Ultraviolet ray is essentially vitalizing, stimulating, bactericidal, immunity raising, and reconstructive; x-ray is basically absorptive, inhibitive, and destructive to the cells and tissues. Ultraviolet light is superficial, x-ray has tremendous power of penetration. They have only one common actinic effect—antipruritic.

It would seem natural, therefore, that these two modalities should have entirely different clinical indications and each its own field of clinical usefulness. It would seem also that because of the difference in their biochemical properties and technical modes of application, their joint use in properly selected cases should be one of the greatest achievements of modern physiotherapy.

My personal experience of over ten years in the extensive use of both x-ray and ultraviolet light leads me to regard them of equal clinical utility, at least so far as the number of cases in which each modality is used. X-ray is infinitely superior in localized deep infiltrative conditions and malignancy. Ultraviolet ray is the method of choice in systemic generalized superficial dermatoses.

The strength of x-ray is in its local effects on the individual lesions. The strength of the ultraviolet ray is in its systemic effects, and its local effects, though less powerful than those of x-ray, are of distinct clinical utility.

In the final evaluation of the therapeutic efficiency there are other factors to be considered, such as the simplicity or complexity of the technique of application, the time necessary for individual and total treatment, the relative safety of the modality, the size of the therapeutic field of application.

Measuring the therapeutic efficiency from this broader point of view puts greater emphasis on biologic systemic reactions and general clinical utility than on the mechanistic capacity of the agency to clear up an individual skin lesion.

It is idle and irrelevant to stamp one or the other modality as the best single therapeutic agency. I would not care to practice dermatology without either x-ray or ultraviolet light.

Radium

While the biologic and therapeutic action of radium is practically identical with that of x-ray, because of the technical differences of application its field of usefulness in dermatology is much more restricted than that of x-ray. The small area of flat applicators and needles reduces the field of application to small lesions.

In my experience radium can be used with very successful, often spectacular results in

epitheliomata of the face, vascular nevi, plantar and subungual warts, occasionally in leukoplakia and discoid type of lupus erythematosus. Surprising results can be obtained with a ten milligram flat applicator. The filtration can hardly be standardized and should be estimated for each individual lesion.

In flat epithelioma of the face, not exceeding the size of the plaque, radium is so invariably effective that I prefer it to x-ray; the average dose is eight, ten, or twelve hours application, single or divided in closely set treatments.

In plantar warts, radium also exerts remarkable curative effect. Three or four hours application is usually sufficient; filtration is hardly necessary since plantar skin in general and the keratotic surface of warts are very radio-resistant.

In subungual warts the required dosage is usually smaller, one to three hours. One of the most spectacular demonstrations of the magic of radium can be seen in the treatment of vascular nevi, particularly cavernous. In nevi I prefer gradual cumulative effects of fractional doses in hourly applications. The filtration varies from .5 to 2.0 millimeters of brass according to the thickness of the lesion. At first, applications are spaced weekly, later every two, three, or four weeks.

In flat keloids, radium also gives magnificent results. The dosage in keloid must be much more massive, and closer set treatments are necessary, as the keloid is a rather radio-resistant tissue.

In ulcerating leukoplakias, very small fractional doses of fifteen to twenty minutes applications without filtration are often beneficial. In proliferating, leukoplakias, I prefer destruction with electrodesiccation. In gold resistant cases of discoid lupus erythematosus, fractional doses of radium with light filtration of .5 millimeters of brass often render excellent results.

According to McKee, the radium plaques are so different in their actinic output that each operator must know the actinic capacity of his plaque. The spacing and number of treatments can hardly be standardized and must be determined on the clinical requirements of an individual case.

Grenz or Bucky Rays

The discussion of actinic agencies would not be complete without the consideration of *grenz* rays.

My personal experience with *grenz* rays is a little over two years old and covers a series of 125 dermatologic cases.

Briefly stated, the *grenz* ray is x-ray of extremely low voltage (8 to 10 kilovolts) which presents the combined biochemical properties and clinical effects seen both in x-ray and ultraviolet light. Thus *grenz* ray produces the early erythema and pigmentation so characteristic of the ultraviolet ray, and later a secondary x-ray erythema with late x-ray sequelae, such as atrophy and teleangiectasias. Because of its extremely low voltage *grenz* ray is very superficial in action and is much safer than x-ray.

The biochemical properties of the *grenz* ray are identical with those of x-ray and differ only in penetration. It can duplicate the results of x-ray in superficial skin conditions. It is measured by erythema and its fractions. Erythema is obtained in three to four minutes at the distance of eight centimeters with eight milliamperes and eight kilovolts. *Grenz* ray is obtained with a specially constructed step-down transformer allowing the production of the extremely low voltage, and a Muller tube.

The general problem of dosage is the same as with x-ray. For this reason *grenz* ray is preferable to x-ray in cases in which skin lesions affect parts covering parenchymatous, radio-sensitive organs, such as eyes, scrotum, breasts, thyroid, and also over the scalp as it does not produce epilation even at the full erythema dose. In my experience it has proven very effective in senile keratoses and superficial epitheliomata, psoriasis, seborrhoic dermatitis, chronic eczema, dry scaly patches of epidermophytosis, and Paget disease.

Yet, in spite of its unquestionable actinic potency in superficial conditions and in spite of its proven greater safety over x-ray, *grenz* ray must be restricted to a very limited, almost negligible field of clinical application in dermatology.

Strange to say, the major therapeutic limitations of the *grenz* ray are due entirely to two factors. The first one is the small aperture of the tube allowing the treatment of only very small areas, not exceeding five centimeters in diameter. The second and more serious objection is the production of persistent

pigmentations resulting from doses even less than erythema. Yet erythema reactions are the dosage required for therapeutic results in a majority of cases. I carry on my own forearms several disfiguring pigmentations and patches of superficial atrophy with beginning punctate teleangiectesias from sub-erythema and full erythema doses given experimentally a year and two years ago.

This possibility of lasting disfigurement renders the use of the *grenz* ray on the face and other conspicuous locations, particularly in blond individuals, extremely hazardous.

As the *grenz* ray can be used at present with successful therapeutic and cosmetic results only in a few carefully selected cases, its use in dermatology can be considered at present a therapeutic luxury.

Conclusions

The above discussion of the actinic agencies seems to allow the following conclusions:

1. The greatest practical problem of scientific physiotherapy at present is to counteract the flood of commercial literature luring practitioners into physiotherapy by extravagant therapeutic claims.

2. The greatest danger to scientific physiotherapy in dermatology is presented by the mechanistic tendency promoted by the commercial literature, to be satisfied to clear up the individual skin lesions without any attempts of intelligent interpretation of the dermatosis as a whole. This tendency reduces physiotherapeutic clinicians to the level of physiotherapeutic technicians.

3. No physiotherapeutist is qualified to treat skin lesions unless he has sufficient grounding in dermatologic diagnosis and is competent to administer other dermatologic therapeutic measures if necessary.

4. As a therapeutic weapon in clearing up individual skin lesions, x-ray is much superior to the ultraviolet ray.

5. As a biologic therapeutic agency contributing to the cure of dermatoses, both through systemic and local effects, and from the point of view of general clinical utility to clinical dermatology, the ultraviolet ray is of equal therapeutic value with x-ray, and is superior to it in systemic dermatoses.

6. Quartz lamp and carbon arc burners are of identical biochemical and therapeutic capacity and are of equal clinical value. The difference is merely in mechanical and technical details.

7. Full and intense erythema doses of the ultraviolet ray are indicated only in a few types of dermatoses. The majority of therapeutic effects are better obtained with fractional doses.

8. R international units, while physically exact, are not serviceable clinically. McKee's indirect method of measuring x-ray dosage is simple, safe, and sufficiently exact for all clinical purposes.

9. Radiologists, as a group, are using in the treatment of skin lesions x-ray of much greater penetration and of a heavier filtration than is advisable or necessary from a dermatologic point of view.

10. X-ray should be reserved for deep infiltrating dermatoses, granulomata, and tumors.

11. Superficial and particularly systemic dermatoses should be preferably treated by ultraviolet ray.

12. The combined and alternate use of fractional doses of x-ray and sub-erythematous doses of the ultraviolet ray is safe, rational, and very effective in a large variety of dermatoses.

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(For concluding references, see page 46)

ARCHIVES of PHYSICAL THERAPY, X-RAY, RADIUM

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E D I T O R I A L S

NEWER CONCEPTS ON MATTER AND RADIATION

Probably no other chapter in the physical sciences has so stimulated the imagination as that which has to do with the modern interpretation of radiation and the nature of matter. These sudies have permitted us not only to envision the interplay of primary forces but have shown us glimpses of its exquisite action, as fascinating in its scope as anything thus far contributed in the field of biophysical research. From this we have learned to appreciate that the boundaries of our knowledge instead of becoming more limited and circumscribed with added experience have instead become more extended in every direction. Each new experience and each new conquest of nature's forces has opened up new vistas, new avenues, new tributaries, new problems which invite further exploration. It is like an endless march on the road to infinity wherein its travelers are urged ever onward to new experiences just beyond their reach.

Our increasing knowledge of the physical and biologic properties of light radiation is a fitting example to what has been remarked above. No other branch in electricity has excited greater interest nor has enlisted more orthodox measures to discover the hidden mysteries inherent in this range of energy. With greater orientation new issues have arisen in regard to the physical nature of radiation and the method of its interpretation. The fascinating theory of Bohr has to a great extent been replaced by the photoelectric theory of Einstein and this in turn has been amplified by several new concepts by de Broglie, Schrodinger and others. The attempt to correlate radiation with matter has, therefore, uncovered some startling facts and has led us to alter our present ideas in regard to matter and light.

Just a few years ago we were certain that light was a wave in the ether demonstrable by refraction, reflection and polarization. Matter was understood to be composed of molecules

and atoms which in turn were made up of electrons and protons. Electrons and protons were conceived to be made up of particles and by their configurations all of the known elements were thus accounted. According to Kramer:

"When an attempt was made to explain one in terms of the other, straightway we found ourselves in trouble for when we tried to explain the structure of the light wave, it remained no longer a wave but took on the semblance of particles, and the electron, when an attempt was made to definitely prove it a particle, began to act as a wave. To deny that this state of affairs constituted somewhat of a dilemma would be dishonest, but it need cause no discouragement since the very fact that both the electron and the light wave refuse to comply with our preconceived notions about them has opened up vast new avenues of thought. It has opened up an entirely new field of analysis and the work of the pioneers in this field, de Broglie, Schrodinger, Dirac, and others is already yielding fruitful results."

It became apparent that there existed certain gaps in the modern theory of radiation that was in need of scientific explanation. Inconspicuous differences between theory and experiment, facts which did not escape the vigilant eye of the investigator, became starting points for new and important researches. Out of the well known experiments of Michaelson-Morley which failed to show earth's influence on the propogation of light came the great structure of Einstein's theory of Relativity. Trifling differences between the measured and calculated values of blackbody radiation gave rise to the Quantum theory of Planck. Discrepancies in this, probably the most revolutionary theory in modern physics and destined to be regarded as one of the greatest contributions of modern times, has stimulated a fresh stream of ideas and suggestions which have materially consolidated present concepts regarding the nature of electronic action and light radiation.

Einstein by his hypothesis of photoelectric effect, has added a new rationale to the Quantum theory of Planck. This hypothesis, or law, attempts to correlate the fact that matter was corpuscular motion, and motion corpuscular matter. According to Kramer, "Assuming that energy consists of discrete particles or small trains of waves which cannot be divided, it is apparent that when such a bundle of energy is directed at an electron, the latter must receive or reject the whole bundle. It cannot accept part of the energy and reject that which it cannot hold. This refers specifically to the absorption of a quantum of energy in removing an electron from an atom. The absorption of one quantaum breaks up only one atom. If the radiation has a frequency above this limit so that its quantum has more energy than the minimum necessary to remove a single electron from the atom, the whole quantum is still absorbed, the excess energy now being used in endowing the ejected electron with motion."

When it was necessary to explain diffraction and interference phenomena, the wave theory was called into effect, which created an embarrassing situation when attempts were made to explain the same phenomena by entirely different theories. This situation has, however, been satisfactorily cleared up by the explanation of de Broglie's brilliant synthesis of both views. According to his work he was able to prove that it is now possible to demonstrate that light, though actually corpuscular, was guided by waves. The implication is therefore astounding in that it postulates a contradictory concept that light was both a particle and a wave at the same time.

The correctness of de Broglie's theory was soon confirmed from two independent sources. In America, Davisson and Germer of the Bell Telephone Laboratories, refracted the electrons from the face of a nickel crystal, while in England, Professor G. P. Thompson obtained refraction by passing a stream of electrons through thin sheets of metal foil. It is rather a striking paradox that Thompson, the son of Sir J. J. Thompson, who first proved the electrons to be particular in nature, should prove the electron to possess the property of a wave.

In this research the proton has not remained free from the inquisitive eyes of modern research. As a consequence of the predictions made by Schrodinger, Heisenberg, and others, Dempster of the University of Chicago, has demonstrated that it also possesses the properties of wave motion. Matter and radiation, therefore, are dual in nature, both discrete and continuous in structure, both essentially some form of a wave. There is, however, a degree of difference in both which may be put this way: matter waves are bound while energy waves are free.

In spite of its academic trend progressive

medicine is today as much interested in the full interpretation of the ultimate nature of things as any mathematician or physicist. It has as many vital interests invested in the problem as any other group. Modern therapeutics recognizes the value of the various forms of radiation now utilized in medical practice. The electron has today invaded the field of chemistry and is no doubt destined to play an increasingly important role in future biological research. Indeed, modern biophysics is even at this moment postulating that the very nature of life is perhaps an electrical phenomena. It is therefore to be expected that any advance or contribution to this field is now regarded as vital to medicine as it is to the mathematician.

But no matter whether the electron in theory is undulatory or corpuscular, certain facts in connection with its radiation activity are today regarded as basic. It is recognized that the electron has mass, electrical charge and a quantum of energy which is proportional to frequency. Using the foregoing facts as a foundation, a logical theory has therefore been built capable of explaining nearly all of the ordinary facts in physics, optics and chemistry.

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"A COMMEMORATION OF JAMES CLERK-MAXWELL"

1831-1879

The world of Science has recently celebrated the Centennial of James Clerk-Maxwell, one of the most brilliant mathematical physicists since the time of Newton. At the commemoration exercises devoted to his memory an impressive gathering of foremost scientists were voluntarily brought together in honor of this event. Each paid homage to the genius of this man from the point of view of his influence upon his time both as a teacher and scientist and called attention to the far-reaching effect of his contributions to future mankind. Said Sir J. J. Thompson,* "We are met to celebrate the centenary of one whose work has had a profound influence on the progress and conceptions of Physical Science; it has moreover been instrumental in harnessing the ether for the service of man and has thereby advanced civilization and increased the safety and happiness of mankind."

According to authentic sources the evolution of Clerk-Maxwell's intellectual development was clearly reflected throughout the several stages in his short life. It glowed fitfully, dimly and timidly in the childhood of his primer school days. The years of approaching adolescence saw the awakening of that mentality which in later years was to be heralded as one of the most profound in the physico-mathematical sciences of his day. His youthful period was largely devoted to independent probing into many avenues of knowledge which not only included the physical and abstract sciences but also that of philosophy, literature and poetry. While his school companions were playing the rough games of childhood sport, he was wont to stand strangely apart and participate vicariously in the Homeric sports of more heroic days. His childhood was made up of that strange combination of mute yearning to understand the strangeness of his environment and the building of defenses around his dream world in order to shield himself from the cruel jibes of his playfellows. As a child his constant question was "What's the go of that?" "What does it do?" and if not satisfied with the answer he would ask "But what is the 'particular go' of it?" Even in this early stage of life his mechanical trend became manifest by his fondness for making baskets and seals covered with strange devices.

His mental development was typical of that strange and intellectual group so rarely understood and most often condemned—a group that is unfortunately misunderstood and derided by their contemporaries because of their non-comformative habits—a defense reaction in reality to the hypersensitive mind for masking the cerebral fires which burn with unaccustomed intensity in the womb of genius. Thus it has been recorded that he mixed very little with other boys, that he was shy and awkward and was mentally slow in his lessons. The formative period in such personalities often glows perversely and because of such perverseness these natures are frequently misunderstood, but sooner or later they find themselves and from then on set the intellectual tempo of their time. It is therefore not strange to read Professor P. G. Tait's estimate, (a contemporary and fellow stu-

dent) regarding the youthful development of Clerk-Maxwell's intellect:

"At school he was at first regarded as shy and rather dull. He made no friendships and spent his occasional holidays in reading ballads, drawing curious diagrams and making rude mechanical models. This absorption in such pursuits, totally unintelligible to his schoolfellows, who were then totally ignorant of mathematics, procured him a not very complimentary nickname ("Dafty"). About the middle of his school career he surprised his companions by suddenly becoming one of the most brilliant among them, gaining prizes and sometimes the highest prizes for scholarship, mathematics, and English verse."

Before he was fifteen he had written a paper regarding a mechanical method of describing curves which unfortunately had been anticipated, as found later, by Descartes. This, however, is an index to the rapid maturing of Clerk-Maxwell's precocious genius for abstract mathematical reasoning, a fact which became more apparent with his educational progress in the higher grades and particularly at Cambridge. It has been remarked that he brought to Cambridge a range of mathematical knowledge extraordinary for so young a man, but in a state of disorder which appalled his tutor. In spite of his shyness and some eccentricities his exceptional powers were early recognized and he became not only a fellow at Trinity but was made one of the "apostles," a club limited to 12 members, who in the opinion of the Club were the men of most outstanding ability in the University. According to Dr. Butler who later became Master of Trinity, "James Clerk-Maxwell's position among us was unique. He was the one acknowledged man of genius among the undergraduates."

Maxwell's genius came to its highest fruition during the five years when he held the Professorship in Physics at King's College, London, (1860-1865). During that period he contributed papers on "The Theory of Color," the two papers "Physical Lines of Force" which with his paper on "The Dynamics of the Electromagnetic Field" contains his theory of Electricity and Magnetism, his Bakerian lecture on "The Viscosity of Air at different temperatures and pressures," as well as two important papers on "The Kinetic Theory of Gases." It goes without saying that while all of the foregoing contributions more firmly fixed contemporary opinion in regard to Clerk-Maxwell's genius as a mathematician of the first order, it was his contribution to the field of electromagnetism that finally won for him the highest honors. Paradoxically, that for which the world now honors him most came belatedly in the form of posthumous recognition. It was ten years after his death that support for his theory of electromagnetic radiation, which among other things predicted the existence of electric waves, came by means of the brilliant research of Heinrich Hertz, a pupil of Helmholtz, and thus fully confirmed the mathematical speculation advanced by Clerk-Maxwell of the existence of electrical waves. Hertz was able to demonstrate that these high frequency waves resembled light in that they could be reflected, that they could be brought to a focus, that like light they could be polarized and most important of all for establishing their wave character showed interference effects from which the lengths of the waves could be calculated. Commenting on this work of Hertz, Sir J. J. Thompson* says, "Hertz's researches were one of the most marvelous triumphs of experimental skill of ingenuity, of caution in drawing conclusions, in the whole history of Physics."

It is to the credit of Hertz on one side and to the influence of Faraday on the other that Clerk-Maxwell owes his present eminence. It was inevitable that Faraday's work would find a receptive intellect to carry it to the heights that it justly deserved. It was almost inevitable that the profound speculations of a Clerk-Maxwell would sooner or later find a corresponding intellect sufficiently great to cope and enlarge upon his work. Planck,* commenting on the influence of Clerk-Maxwell on contemporary thought says:

"A great investigator influences the intellectual world in the first instance through his scientific results. These are most immediate and the most valuable fruits of his life work. Often, however, a great personality will wield an influence of a less direct kind, but one often of comparable importance. This may arise through the stimulating influence exerted by such a man upon a group of sympathetic contemporaries, through whose agency his scientific gifts may bear further fruit. In the field of the sciences of the mind it is not always that this distinction between direct and indirect influence can be sharply made, since a moulding of cultured opinion may well be a part of his endeavor. But in science, where the worker and the objects of his investigation are clearly distinguished, it is much easier to follow in detail the way in which a great investigator may achieve immortality, not only through his own discoveries but also through those that he inspires others to make.

"There are, however, in every science certain exceptional individuals, who appear divinely blest, and radiate an influence far beyond the borders of their land and thus directly inspire and expedite the research of the whole world. Among these is to be counted James Clerk-Maxwell, the centenary of whose birth is now being celebrated. Although one cannot doubt that all that he achieved over the whole field of physics would sooner or later have become the common knowledge of science, even had he never lived, but to him belongs the honor not only of so many first discoveries, but of having served so well his contemporaries of all lands by his stimulating influence and by having saved them from many arduous and useless bypaths."

Einstein's* appreciation of Clerk-Maxwell's profound labors in the field of mathematical sciences is no less definite than that of Planck. He says, in part:

"Before Maxwell, Physical Reality was thought of consisting of material particles. . . . Since Maxwell's time Physical Reality has been thought of as representative by continuous fields. . . . This change in the conception of Reality is the most profound and the most fruitful that Physics has experienced since the time of Newton."

Probably no other contribution of a mathematical nature has had such a vast and profound influence on modern physical science as those of Clerk-Maxwell. It has led to new avenues of research, the like of which has not been duplicated in any other age. The Unknowable in our physical environment has been materially erased. Stellar and interatomic phenomena have been reduced to understanding equations and are now even demonstrable to the lay mind. Out of these contributions have evolved social economic benefits to mankind, due to the additional researches of men like Marconi, Fleming, De Forest, Edison, Tesla, etc. In the field of the physical sciences there has developed a new school of thought led by Planck, Bohr, Eddington, de Broglie, Jeans, Einstein, Michaelson, Millikan, Compton, etc. In Medicine, electromagnetic radiation has offered certain healing energies which are being utilized in our therapeutics with definite and spectacular results. High and ultra-high frequency currents are now used for profound local and hyperpyretic heating effects. Phototherapy utilizes other spectral regions of the same electromagnetic spectrum in order to elicit heat from one side and photochemical effects on the other side of the same spectrum. X-ray and radium have become established therapeutic adjuvants of highest service to the medical profession. On the basis of what has already been accomplished it can be anticipated that what has already been discovered will compare in value to what will be contributed by future scientists to the introductory overture that precedes the major opus of classical opera. And in this prediction we do not stand alone but are supported by no less a scholar than a contemporary and friendly rival of Clerk-Maxwell, namely the great German mathematician, Boltzman, who compared the work of the latter to that of a majestic and sublime musical drama.

According to Planck, Clerk-Maxwell's "name stands magnificently over the portal of classical physics, and we can say this of him: by birth James Clerk-Maxwell belongs to Edinburgh, by his personality he belongs to Cambridge, by his work he belongs to the whole world."

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ANNOUNCEMENT OF ELEVENTH ANNUAL SCIENTIFIC SESSION OF THE AMERICAN CONGRESS OF PHYSICAL THERAPY

Although it is only a short time since the tenth annual session of the Congress was held at Omaha, plans are already under way for the eleventh annual gathering which will be conducted in New York, September 6, 7, 8, 9, 1932. The Hotel New Yorker has been selected as the official headquarters. All scientific meetings as well as the technical and scientific exhibits will be held in this beautiful new hostelry. The facilities which are unusual should add much to the success of the 1932 convention.

The committee is already engaged in planning a most attractive program. Nothing will be left undone to make the meeting interesting and profitable to those who attend. Several foreign guests have accepted invitations to be present. In addition numerous outstanding authorities from this country will occupy leading places on the program. Special features will include round table talks, informal conferences and demonstrations. The subject of therapeutic fever by diathermy and other physical agents, now so prominent in the investi-

gative field, will come up for considerable discussion by workers who are seeking to rationalize this newer treatment in general paresis and in other chronic ailments.

The Congress has always endeavored to make its meetings of special interest to the general practitioner. The specialist, too, has profited by the scientific presentations. As a rule the programs have been well balanced and every specialty has had due representation. This year, an unusual effort will be made to again carry out this plan. With the many new features which will be added, the program should appeal to practitioner and specialist alike.

Several of the local county medical societies have assured the Congress of their support. The New York Physical Therapy Society, through its president, Dr. William Bierman, is cooperating to the fullest extent. The local committee on arrangements is headed by Dr. Norman E. Titus as chairman. All matters pertaining to the convention which can be handled with the New York committee should be taken up with Dr. Titus whose New York address is 57 West Fifty-seventh Street.

The facilities for the commercial exhibits are most attractive. Diagrams are now available at the executive offices, 30 North Michigan Avenue, Chicago, and also at the office of Dr. Titus, in New York. As numerous requests have already been made for reservations, it is suggested that manufacturers and dealers who have not received diagrams, correspond immediately with the Chicago office, or with Dr. Titus, the New York chairman.

The outlook for the 1932 gathering is indeed an encouraging one. This is the first time that the Congress is meeting in the east. New York's urging invitation has finally brought the eleventh annual convention to America's metropolitan city. Inasmuch as a great interest in physical therapy is manifested in the New England and Middle Atlantic states, and, inasmuch as some of the outstanding teachers and clinicians who know physical therapy come from these sections, a program such as is usually put on by the Congress should attract the largest attendance which has ever been present at a physical therapy convention in the United States.

The program committee extends an invitation to fellows of the Congress and to teachers and clinicians who desire to present the results of their investigations in physical therapy and allied fields, to take an active part in the scientific program. Correspondence should be conducted with Marion G. Smith, executive secretary, 30 North Michigan Avenue, Chicago. It is planned to complete the preliminary program by April 1st. Titles of papers should reach the executive secretary before this date.

QUERIES AND CLINICAL NOTES

Q. What special advantages are there in the therapeutic fever produced by diathermy as compared with malarial treatment of paresis?

A. King and Cocke (*Southern Medical Journal,* March, 1930), enumerate the chief advantages of pyretotherapy produced by diathermy as follows:

(1) It is always available.

(2) No pathologenic organism of unknown effect is injected into the patient.

(3) The frequency, duration and intensity of the febrile paroxysms are under accurate control.

(4) The desired elevations can be produced in all cases, which is advantageous in cases that have an immunity to malaria.

(5) Drug therapy can be used in conjunction with this form of pyretotherapy if desired.

(6) Since the frequency, duration and intensity of the fever can be accurately controlled, the reaction produced in each patient can be more nearly standardized. This will enable us to learn the most favorable temperature curve.

Q. Has any investigation been made on the treatment of diphtheria carriers by Roentgen ray?

A. Humphrys, Withers and Ranson (*Colorado Medicine,* May, 1926), reported on thirty-nine cases of diphtheria carriers treated with very well filtered roetgen rays generated at an actual voltage of 200,000, corrected to a sea level reading. In no case was there given more than 60 per cent of an erythema skin dose, which is just sufficient to cause some dryness of the mouth, due to the effect on the parotid, and in some cases a very slight cervical lymph adenitis. Two febrile reactions occurred simulating an acute tonsillitis. Neither lasted more than one week. Of the entire series, only four cases remained positive, eighty and eighty-five days, after the first roentgen-ray treatment.

Q. Of what benefit is heliotherapy in pulmonary tuberculosis?

A. Numerous articles have appeared in the medical literature concerning the value of heliotherapy in pulmonary tuberculosis. One by Howson (*Cal. and West. Med.,* July, 1928), speaks of sun and air baths, properly used, of definite benefit to tuberculous patients.

They may be contraindicated because of (*a*) the type or stage of the disease or (*b*) the inability of the patient to react owing to constitutional or acquired disabilities. Their use requires a knowledge of the dangers, a proper graduation of the dosage, and close observation for unfavorable reactions. Neglect of these precautions may lead to serious and even fatal consequences. Artificial sources of light may be used on dull days when the sun is not available. Present knowledge, while very incomplete, justifies the following statements: (*a*) It is desirable that the rays from these lamps approximate in composition those of the sun, and (*b*) the claims for the great superiority and freedom from danger of the ultraviolet rays to the exclusion of the balance of the solar spectrum are not justified.

Another interesting account is that by Bullock (*Am. Review of Tuberculosis,* April, 1928), an abstract of which appeared in the *J. A. M. A.,* June 2, 1928. The abstract follows:

"It is a widely held opinion that sunlight is of little or no use in pulmonary tuberculosis, and this, from long experience, Bullock says he knows to be correct. But airbaths are of great importance, and the time will come when, in favorably located institutions at all times of the year, and in others less favorably situated part of the year, tuberculous patients will be stripped of clothing—all but a breachcloth as a concession to decency. Patients so exposed do not take cold easily, are not so dependent on artificial heat, appear better, feel better, eat better and, briefly, recover faster and more surely."

Q. Has the radium treatment of hemangioma proved successful?

A. According to Andréu (*Acta Radiologica,* Feb. 28, 1927), the radiologic treatment of nevus and gives an account of its pathology and clinical manifestations. He describes the technic employed in treatment of 288 cases of hemangioma, eleven cases of lymphangioma and sixty-nine cases of epidermal nevus. Seventy-six cases of capillary, 138 of superficial cavernous and fifty-nine of deep cavernous hemangiomas were treated with radium and in a few cases with roentgen rays. As a rule, each dose was 80 per cent of the erythema dose and the intervals were of considerable length. The hemangiomas were carefully watched between the treatments and the dose was not repeated until improvement had taken place. In treatment with roentgen rays, the dose generally was one-fourth of the erythema dose and a 4 mm. aluminum filter was used. In capillary hemangioma cosmetic restoration was obtained only in children under 1 year of age and then only in cases where the size of the hemangioma did not exceed 10 by 35 mm. In more extensive hemangiomas the treatment did not lead to cosmetically satisfactory results. Of superficial cavernous hemangiomas, about 70 per cent were cosmetically restored and about 30 per cent improved. The cavernous hemangioma frequently grows rapidly during the first year of life and should therefore be treated during this time. Of fifty-nine cases of deep cavernous hemangioma, cosmetic restoration was obtained in twenty-eight and improvement in seventeen. Treatment with an extra lead filter, 2 or 3 mm. thick, brought about cosmetic restoration in two of eleven cases of cavernous lymphangioma. In eleven cases of nevus pigmentosus and thirty-five of pilose nevus pigmentosus cosmetic, restoration was obtained when electrocoagulation was substituted for radium treatment.—*J. A. M. A.,* June 4, 1927.

Q. What success has been achieved by diathermy operations for cancer of the tongue.

A. Workers in this country and in Europe have reported good successes with surgical diathermy in tongue cancers. At least the results are far superior to those obtained with the cold scalpel. Wyeth, Kobak and others have performed extensive resections of carcinomatous growths by electrocoagulation and by the electrosurgical knife. Harmer (*Brit. J. of Surgery,* April, 1928), gives an interesting report on the subject:

"The results that have been reported from the use of diathermy in the treatment of cancer of the tongue, Harmer says, are so encouraging that there can be no doubt that it is one of the best methods of treatment that has so far been devised. If the operation is properly carried out by the bloodless method, there is no danger of disseminating the growth. Certainly it is easier to operate by this means than with the knife. The treatment can be carried out in a shorter time, and there need not be any handling of the tissues. Complications are also less frequent than after cutting. Thus, there is less shock and toxemia. The absence of pain is remarkable, and allows of easier swallowing. The sloughing that results is harmless. Many cases which would be considered inoperable by ordinary means can be relieved, if not cured, by the method — in fact, it may be the only means of sterilizing a painful septic sore. Even if life is not prolonged, the existence of the patient may be rendered more bearable."

(Concluding references of Scholtz)*

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(Continued from page 38)*

CURRENT NEWS AND SCIENCE

Millikan Offers New Data on Cosmic Rays

In the depths of space, where atoms are sparse, a cluster of four hydrogen atoms, free from collisions for a long time, will jump over their potential wall and form a nucleus emitting a cosmic ray, Prof. Robert Andrews Millikan, of the California Institute of Technology, declares. Dr. Millikan's theory is based on the demonstration that atomic changes not found on the earth occur in the nebulae, where atomic collisions are infrequent. Dr. Millikan's new researches during the past summer support the view that cosmic radiation consists of the wirelessed birth-cries of helium, oxygen, silicon and iron, synthesized from hydrogen in interstellar space. His report was presented at the recent meeting of the British Association for the Advancement of Science.

Both Dr. Millikan and Sir Oliver Lodge attacked the second law of thermodynamics. "It is merely a generalization based on observation on earth, that all energy tends to be converted into heat and radiated away, hence lost," said Dr. Millikan. "A final inevitable increase of entropy to a maximum is a bugbear idol to which philosophers need not bow the knee," said Sir Oliver.

He also contended that the application of the unvivified laws of physics to the universe assumes there is nothing or no one to wind it up or guide it to some nobler end.

Referring to the new quantum theory, he said: "Guiding waves determine the path of a particle of matter. Whether there is any connection of life and mind is still an unanswered question." — *Science News Letter,* October 10, 1931.

Pacific Physical Therapy Association

We are gratified to note that organized medicine on the Pacific coast has accorded space in their official *Bulletin* for program announcements to the Pacific Physical Therapy Association which is tantamount to recognition that this association is representing the scientific interest of the above mentioned districts in things concerning Physical Therapy. This is progress in the right direction, and, no doubt, is due to the indefatigable work of its secretary, John Severy Hibben, also a leading officer of the Congress.

The program in question was held at the Hotel Alexandria, Los Angeles, on the evening of Wednesday, December 9. An informal banquet was tendered to the distinguished guest, Edgar Mayer, of Saranac Lake, N. Y., and New York City, associate professor of medicine, Post-Graduate Medical School, New York. The topic of Dr. Mayer's discourse was: "Are We Abusing Our Patients with Light?" The speaker of the evening was introduced by Carl R. Howson, M.D., president, Los Angeles County Society, and was discussed by Harold M. T. Behneman, M.D., T. Howard Plank, M.D., and Professor C. C. Laurritsen. The association is to be congratulated on this fine program and in their selection of these representative men who by virtue of their wide experience were able to throw much light in regard to the mooted question whether we are abusing our patients with too much light. It is certain that the audience came away much enlightened (we were about to say "illuminated," but fear of one confusing this cerebral state with the not unusual physical state satirized as "lit up," has forced the commentator to use the less fitting word "enlightened," even though it is reminiscent of an intended pun). It is hoped that this is but the beginning of a program in which other distinguished authorities will be enlisted to discuss other phases of physical therapy of value to the medical profession.

The Doctor and Hard Times

The present financial depression throughout the world has its effect on all sorts and conditions of men and, among others, on the doctors. If we leave out of consideration the losses to individual physicians dependent on the depreciation in value of securities which they happen to have possessed at the time of the crash, we still have the general effect on the work and prosperity of the profession to consider. This is dependent directly on the

financial situation of the world in general. In one matter, however, the doctors are more fortunate than people in other walks of life — they are not out of work. However impoverished the people may become, they still persist in being ill and have to be cared for by somebody. Thus the free clinics are overcrowded and the practicing physician, who, by the way, may be overworking in some of these clinics, finds that, though his private work keeps up, his income dwindles because people do not pay their bills. Surgical practice becomes more and more restricted to operations of necessity only, and private hospitals and sanitaria are finding it hard to keep their beds filled. Funds for the support of medical research are very hard to obtain and a definite retardation in the advance of medical knowledge must result. The picture is an unpleasant one and blends well with the evidence of depressing economic conditions seen everywhere. Nevertheless we of the medical profession are in many ways more fortunate than are others. At least we have our jobs, with as much to do as ever. In spite of the necessity to get along on reduced income we can go ahead cheerfully. The conscientious doctor regards his income merely as a by-product of his work and he will carry on, consistently reducing his fees wherever the unfortunate condition of his patients demands such action, doing his best to conserve the health of his community and withal on his own part to "make both ends meet."—(Editorial, *The Rhode Island M. J.*, November, 1931.)

When people have died from shock with a supposedly low voltage of electricity such as from household circuits and appliances, it has been explained on the ground that the voltage had suddenly become greater than the usual 110 or 120 volts. Dr. Horatio B. Williams, New York, offered another explanation based on physiological rather than physical grounds in a paper read at the Philadelphia session of the American Medical Association.

Within recent years medical scientists have learned that under the pressure of a very low potential, often much less than 110 volts, electricity may affect the heart and cause a sort of tremor or wavering in its usual contractions, technically termed fibrillation. Instead of all the muscle fibers of the heart contracting together they each contract separately without coordination. When the current passes through one part of the heart this fibrillation occurs without interfering with the circulation, but when the current passes through another part of the heart the circulation stops at once and death usually follows.

When the human skin is dry it is not a good conductor but when wet the skin becomes a powerful conductor and currents large enough to cause fatal fibrillation of the heart could pass. — (*The J. of the Missouri S. M. A.*, Sept., 1931.)

Effects of Electric Shock On Rats are Determined

If a 1000-volt electric current passes through the body of a rat between his front leg and his tail, he has almost an even chance to recover. But if the path of the current is from front leg to hind leg, he is pretty sure to succumb. This difference in effect was discovered by W. B. Kouwhenhoven and O. R. Langworthy of the Johns Hopkins University. It is explained by them, in a report to the American Institute of Electrical Engineers, on the ground that a current flowing from front leg to hind leg finds less bodily resistance than in the other case, and, as a result, becomes high enough to cause death.

In the course of the experiments the conclusion was reached that a continuous current is much more dangerous to rats than an alternating one of the same voltage. Burning of tissues was reported as being more severe when produced by a continuous current.

Points of electrical contact on the rats were varied purposely. A current passing from one fore leg to the other was found to be fatal in every case, while a current from hind leg to hind leg produced only temporary disability. It was also discovered that injury caused by the current going from left fore leg to tail was less severe than that caused by the same current flowing from right fore leg to tail.

According to experimenters, the conclusion made by another investigator that an electric current passing through the brain stops the breathing process for a time, was confirmed It was also found that the brain cells can be fatally injured by an electric current. When vital organs were not in the current's path the effects were not serious. — *Science News Letter.*

Fevers Given Children to Check St. Vitus Dance

Fevers, used these days to burn out certain ailments of the human system, now seem to check St. Vitus dance in children.

Twenty-four children have been treated by fevers artificially produced by manufactured serum. Dr. Lucy Porter Sutton, working in Bellevue Hospital in New York, reported these cases to the American Medical Association. The average time of the children in the hospital was nine days. Sixty-three cases used for comparison treated by other means stayed on an average of forty-seven days in other hospitals. The usual treatment is rest and quiet.

Dr. Sutton used typhoid-paratyphoid serum because it gave fevers for successive days which promptly stopped the symptoms. The discovery was an accident. Dr. Sutton was treating an extreme case of St. Vitus dance in a boy. He was given a drug as a sedative. It had no beneficial effect and only aggravated the disease. But through a misunderstanding the drug was not stopped until the thirteenth day when a rash and a fever developed. This was traced to poisoning from the drug. It was noted however, that the disease abruptly improved, after an irregular fever that rose as high as 106.4 degrees. A consideration of various factors convinced Dr. Sutton that it was the fever that cured.

She then tried small doses of typhoid serum because it was a safe and simple way of giving fever, and found it effective in cases tried. Later, typhoid-paratyphoid serum was chosen because it was a still simpler, safer, and cheaper way of giving fever. — *Science News Letter,* August 15, 1931.

New Device Lessens Danger From Treatment with X-Rays

The Danger of burns during X-ray treatments has been greatly lessened according to Dr. Lauriston Taylor of the U. S. Bureau of Standards, by the completion and final testing of apparatus designed to measure the intensity of X-ray doses.

"Until now, no exact and uniform measurement of the strength of X-rays has been possible," it is explained by Dr. Taylor, who has just returned from Europe with the primary X-ray standard which he designed for the United States. "Now a doctor may calibrate his apparatus to learn the intensity of his X-ray doses without the necessity of guesswork. He will not burn his patient, nor will he commit the worse crime, in cases such as cancer, of undertreating him."

According to Dr. Taylor, there are two factors in X-ray treatment, the intensity and the penetrative power of the rays. The rays' penetrative power depends on the shortness of its wavelength, longer waves having a burning effect. The intensity of the X-ray dose is more important, and it is this intensity which he can now measure.

For three months Dr. Taylor experimented in European national standardizing laboratories, consulting foreign scientists and comparing his apparatus with theirs. Before that he labored at his instruments in the Bureau of Standards in Washington, D. C., to construct a portable X-ray standard, finally building one which is so simple that he could take it with him, and so accurate and dependable that it is designated as the primary or final standard of the United States. This he compared with foreign instruments, drawing up with European scientists specifications for an international standard to remedy international confusion. This new apparatus is the only one in the world that completely satisfies these specifications, Dr. Taylor says.

Uncle Sam's X-ray yardstick is in reality a small metal chamber into which X-rays are projected in a steady, uniform beam. When the rays pass through the air in this chamber they ionize the air, that is, set loose free electrons. This causes the air to become a partial conductor of electricity, which may be measured by an electric current and meters. The strength of this current depends on the strength of the X-rays.

France, Dr. Taylor said, had been comparing X-rays with radium emission, but the X-ray intensity as thus measured with the ray's wavelength. The English laboratories did not guarantee steady and uniform transmission of the ray being gauged. The American apparatus does away with both difficulties, and furnishes as nearly as possible a means for transmitting, maintaining and measuring a ray of uniform and standard intensity independent of all other conditions. For this reason France, Egypt, and several other countries have adopted Dr. Taylor's

specifications outright, and other countries have drawn up specifications which at present his apparatus alone fits.

"It is now up to the Bureau," Dr. Taylor said, "to find a means for gauging exactly the penetrative qualities of the various X-ray wavelengths. The intensity of a ray used in medical treatment is but half the problem. Not until we have both standards can we call our standardization work complete."—*Science News Letter*, November 7, 1931.

Scientist Says Universe is Actually Exploding

The universe is actually exploding and the galaxies are scattering apart at a terrific rate, Sir Arthur Eddington, professor of astronomy at Cambridge University, contended before the British Association for the Advancement of Science hundredth anniversary meeting. In support of his contention he presented computations based solely on pure mathematical and physical theory, without the use of astronomical data. The rate of nebular recession thus obtained is in close accord with Dr. Edwin P. Hubble's Mt. Wilson Observatory figures for the red shift of nebular spectra.

Prof. Hubble said, "Detailed theories of stellar evolution are overshadowed by the fact that the time scale is again in the melting pot. With a rapid-expansion universe, a very long time scale of billions of years, fashionable recently, becomes exceedingly incongruous. We have to accept an age of ten to the tenth power or ten billion years for galaxies and presumably also for stars."

Since the age of the earth alone, derived through the radioactive method, is over a billion years this embarrasses astronomers, geologists and biologists. Prof. Eddington derived the actual rate of expansion of the universe from the wave equation for the electron, which is the fundamental equation of the modern quantum theory. This equation, adapted to the curvature of space, contains the term: "the square root of the number of electrons in the universe divided by the radius of the universe in a state of equilibrium," which term is the mass of the electron, usually written: $\frac{M\ C^2}{E^2}$

Combined with the formulae of the relativity theory, this gives the principal data of the size of the universe. Its original radius was 1,070,000,000 light-years, before it started expanding. Its rate of expansion is 528 kilometers per second per megaparsec, compared with 465 derived from the Hubble astronomical data. It is over a hundred miles per second for each million light-years' distance. "The close accordance of the theory with observation forces acceptance of an alarmingly rapid dispersal of nebulae, with important consequences in limiting the time available for evolution," Prof. Eddington concluded.—*Science News Letter*, October 10, 1931.

British Report Most Potent Form of Vitamin D Yet Known

A crystalline form of vitamin D, more potent in its ability to prevent and cure rickets than any similar preparation now known, has just been prepared by a group of scientists working at the National Institute for Medical Research in London.

The men who have made this remarkable scientific contribution are Drs. F. A. Askew, H. M. Bruce, R. K. Callow, J. St. L. Philpot and T. A. Webster. The leader of the group, Dr. R. B. Bourdillon, was prevented by illness from taking active part in the last stage of the work.

This new form of vitamin D is called "calciferol" by its discoverers. They say of it:

"The antirachitic activity of calciferol is the highest yet recorded in known units for any preparation."

Calciferol has more of this antirachitic potency than the crystalline preparation of vitamin D recently reported by the German Nobel Prize winner, Prof. Adolf Windaus of Goettingen, Germany, the British investigators state in their report to *Nature*.

Prof. Windaus has two vitamin D substances which he calls vitamin D_1 and vitamin D_2. Calciferol is not the same as D_1, but is much like vitamin D_2 in such physical properties as have been described. Prof. Windaus' vitamin D_2, however, has approximately the same activity against rickets as D_1. In this it differs from calciferol, which has much greater antirachitic activity than D_1, the British scientists found. Consequently, they concluded that the two substances, calciferol and D_2, are not identical.

Calciferol has been proved by them to be a direct product of the irradiation of ergosterol, known for some time as the parent substance

of vitamin D. It has the same elements in the same relative proportion as ergosterol, although the structure of its molecule may be different from that of ergosterol. — *Science News Letter,* December 5, 1931.

Long Light Waves Used in Treating Sunburn

A new method of treating severe sunburn has been tried by a Swiss physician, Dr. F. Bircher.

The method consists in exposing the patient to light rays of long wavelength, Dr. Bircher reported to the *Schweizerische Medizinische Wochenschrift,* Swiss medical journal.

He has tried it on only one patient so far, but the results were surprisingly favorable. The method is based on the fact that the effects of prolonged exposure to rays of short wavelength, especially ultraviolet rays, can be counteracted by rays of long wavelength. It is the short wavelength rays of sunlight that produce sunburn.—*Science News Letter,* November 21, 1931.

Nobel Chemistry Award to German Industrial Leaders

The Swedish Academy of Science has announced the award of the 1931 Nobel Prize in Chemistry to Dr. Friedrich C. R. Bergius and Dr. Carl Bosch of Heidelberg, for their outstanding achievements in industrial synthetic chemistry.

The German winners of the prize in chemistry are two of the world's foremost practitioners of the magic of industrial science. Dr. Bergius has for many years performed marvels in the transformation of coal, changing it into motor fuel, lubricating oils, methanol (formerly known as "wood alcohol) and other substances. He had developed a scientific theory on the things that must have happened to the plants of long ago to turn them into coal; and his latest feat has been to indicate the possibility of making sugar out of wood on an industrial scale for the manufacture of alcohol. A firm for the commercial exploitation of this process is already in existence.

Dr. Bosch, sharer of the prize, and head of the huge German chemical manufacturing firm, the I. G. Farbenindustrie, has specialized in the building up of cheap nitrogen into more valuable products, as his associate has worked on the building up of cheap carbon. Dr. Bosch's great achievement has been the perfection of a practical method for catching nitrogen from the air so that it can be combined with hydrogen to make ammonia by the Haber process. This in turn is used in the manufacture of fertilizers. Thanks to this process, blockaded Germany literally lived on air to a considerable extent during the war, and even captured from the atmosphere an indispensable ingredient for smokeless powder, TNT and other explosives.

Dr. Bergius was born in 1884 near Breslau, and studied at the Universities of Breslau, Leipzig and Berlin and the Technical University of Karlsruhe. Dr. Bosch was born in 1874 in Cologne, and studied at Cologne, Charlottenburg and Leipzig.—*Science News Letter,* November 21, 1931.

Ultraviolet Light Used in New Photographic Process

Photographic plates sensitive to ultraviolet light will shortly be made commercially by a new process, Dr. C. E. K. Mees of the Eastman Kodak Company has reported.

"Schumann" plates used for this purpose 'till now were difficult to make and had to be prepared by hand. They had a coating either entirely free from gelatine or containing only a small trace of gelatine to bind the silver bromide.

In order to avoid the use of Schumann plates, two Frenchmen, Duclaux and Jeantet, suggested the treatment of ordinary plates with a fluorescent substance which glows when exposed to ultraviolet light, and they employed petroleum oils to paint it on the plates. Satisfactory results have been obtained by many workers with petroleum, but it is difficult to apply the oil uniformly and to remove it before development.

R. E. Burroughs of the staff of the Kodak Research Laboratories tested a large number of organic substances and found the most suitable to be ethyl dihydrocollidine dicarboxylate, which fluoresces strongly in the ultraviolet. This substance can be applied in organic solvents, from which it crystallizes in microscopic crystals over the surface of the plate, these crystals being easily removed before or during development. — *Science News Letter,* December 12, 1931.

THE STUDENT'S LIBRARY

STUDENT'S LIBRARY

100 REZEPTE MEDIZINISCHE DIATHERMIE. By Dr. *Carl Peter.* Price, Rm 2. (50 cents.) 56 pages. Berlin and Wien. Urban & Schwarzenberg. 1931.

This small volume answers the long felt need for an outline prescription method as applied to diathermotherapy. Its contents are equally divided by first presenting the purport and description of the principles in back of the subject, its practical application and action, and 100 directions or recipes for the administration of diathermy. The first section is devoted to a discussion of the principle involved in medical high frequency construction, a comparison of the various electrical currents utilized in medical treatment, directions for its application, its indications and contraindications, the interpretation of electrode utilization, the dosage and time factor in medical diathermy and a differentiation of the various intensities of heat for various conditions to be treated. The author has managed to present the salient facts of all the component factors involved in the uses of medical diathermy, and this in spite of the limited space devoted to the subject. It is to be expected, therefore, that detail has been sacrificed for brevity. The book, however, is of practical value and a contribution in so far as it has utilized the skeletal descriptive form for presenting the 100 practical suggestions, or recipes, for diathermy treatment. This section describes the technic for treatment of various portions of the body. For example, it includes practical suggestions for treating the upper and lower extremities by the through and through and by the cuff method, as also for chest, abdomen, back and pelvis, and head and neck. This section also gives suggestions for application of general diathermy.

The book is of pocket size. Its practical value is so apparent and its cost so limited that it no doubt will enjoy the widest circulation among technicians and practitioners employing diathermy.

ARTIFICIAL SUNLIGHT. COMBINING RADIATION FOR HEALTH WITH LIGHT FOR VISION. By *M. Luckiesh,* D.Sc., Director, Lighting Research Laboratory, Edison Lamp Works, National Lamp Works, General Electric Company, Nela Park, Cleveland, Ohio. Pp. 254, with many charts, tables, and plates. Cloth. Price, $3.75. New York: D. Van Nostrand Company, Inc. 1930.

The question of artificial radiation has enjoyed the attention of outstanding scientists and medical investigators for many decades. It is only in recent years that much of the mystical concept that has gathered about this source of energy has been stripped of its redundant pseudo-science and the essential facts placed before us to be disposed of according to our interests. This is particularly true in regard to the physical and physiologic qualities of infrared, visible and ultraviolet radiation. The medical profession in particular have suffered from premature conclusions regarding the nature and effectiveness of these energy sources, because of indifferent contact with scientists oriented with this form of energy. Thus, much of the information fed to the medical profession as basic has often emanated from unreliable sources. The greatest offender has often been the physician himself who, prompted more by over enthusiasm than by actual knowledge has rushed into the publication of opinions which eventually had much to do in arousing undesirable criticism for the method and of its practice.

The present volume is, therefore, a welcome and timely addition to the literature on the subject, being written by one well oriented and an authority on the subject. "In this treatise," according to the author, "effects of radiant energy have been coordinated with the physics of the subject—a combination which is often incomplete in biological researches and in therapeutic practice. For this reason it is hoped that the data and discussions in these chapters will be helpful to physiologists, biologists, the medical profession and others primarily interested in health maintainance . . . ." The author has so modulated his exposition as to stress the physical nature of the radiant energy that is restricted to the spectral bands recognized as belonging to the divisions of heat, light, and ultraviolet radiation. Twelve chapters have been devoted to the foregoing exposition. A great amount of space and detail have been extended to the nature and effect of ultraviolet action. There is incorporated also a consideration of the value of the electric arc for lighting and health purposes and attention is called to the new General Electric Tungsten filament (type S-1) lamp. Infrared radiation and its therapeutic usefulness has been expatiated upon at considerable length. The author has incorporated in this chapter a large amount of scientific observation from which to draw his conclusions regarding the efficacy and limitations of infrared rays. By far this is one of the soundest expositions on this somewhat misunderstood form of radiation that has been written into popular language.

The book as a whole is a striking example of sound science and coherent exposition, presented by one experienced in the mechanics of clear writing and logical thinking. The author, perhaps unconsciously, has set a high standard for future contributions in the field of light and heat radiation. It may not perhaps appeal to those who judge the science by the quantity of the mathematical formulas, but on the contrary the absence of these confusing and distracting formulas has made for a better understanding of the subject, and as such, the book has achieved its objective, that is to say,

it will be read with understanding and appreciation. We heartily recommend it to the profession.

A TRIBUTE TO MICHAEL FARADAY. By *Rollo Appleyard.* Pp. 204, illustrated with 19 cuts. Cloth. Price $2.50. New York: R. H. Smith, 1931.

This volume is an intimate biography, and one of the most interesting the reviewer has had the privilege of reading. The author has presented a most exhaustive account of "his parentage, his environment, his mode of thought and operation, his sympathies, his difficulties, his victories, and his passion for truth." His personality has herein been so vividly painted that one feels as though this great man was still in our very midst.

Faraday was of such humble parentage that no definite records can be found of his birthplace. Poverty harrassed him not only in early life, but because of his steadfast devotion to science he never became financially independent, even in later life. Faraday at 22 became the amanuensis of Sir Humphrey Davey, then a lecturer at the Royal Institution. In his letter of application young Faraday included some lecture notes which he had taken and which so impressed Davey as to the boy's power of attention and zeal that he sent for Faraday and shortly afterwards gave him the appointment which resulted in his life long connection with the Royal Institution, and the opportunity of developing his later epochal discovery. On March 8, 1813 Faraday was appointed as an assistant in the laboratory of the Royal Institution at a salary of 25 shillings a week.

That Faraday was an inspiration even in his own day is exemplified by the fact that in 1854 when James Clerk-Maxwell graduated with highest mathematical honors at Cambridge University, Faraday's researches became his favorite post graduate studies. Faraday was meticulous in answering all letters which came to him. The author has included excerpts from many of these letters, preserved in the Royal Institution and the Science Museum, to and from such persons as Bönn, Oersted, Amperè, Volta, and Maxwell, indicating the extent of labor to which the author has gone to give his reader authentic information. There is nothing, we think, quite as inspiring as original writing. Opinions thus formed give one an intangible feeling of ownership. So informal and realistic are these bits of intimate writing woven into the book that one has the experience that he too, has browsed through these great museums and institutions.

The author in his preface calls attention to the interesting fact that, "It is noteworthy that as James Clerk-Maxwell, to whom frequent reference is made in the text, was born on June 13, 1831, and, as the British Association held in that year their first meeting, 1931 is in a triple sense a centenary for natural science." We mention this because Faraday's prophetic visions were not understood until his great disciple, Maxwell, had revealed his master's meaning. Even then, years elapsed before the world understood Maxwell's message.

Physical therapy with its intimate relationship owes much to this man who one hundred years ago succeeded in "obtaining electricity from ordinary magnetism" and made possible electricity for "lighting, heating, chemical processes, medical and surgical requirements." The inspiration, enjoyment and knowledge derived from this book recommend it at once as a volume which you will want to own.

THE DISPLACEMENT METHOD OF SINUS DIAGNOSIS AND TREATMENT. A Practical Guide to the Use of Radiopaques in the Nasal Sinuses, with 146 illustrations and a chart. By *Arthur W. Proetz,* A.B., M.D., Assistant Professor of Clinical Otolaryngology in the Washington University School of Medicine. Cloth. Price, $6.00. 242 Pp. St. Louis: Annals Publishing Company. 1931.

As the author of the foreword states: "From the practical standpoint, this contribution is of greatest benefit because of the meticulous description of the technic of the use of radiopaques and other fluids in the diagnosis and treatment of nasal sinus disease."

The author's conservative stand regarding the displacement method is obvious throughout the text. The method has attracted wide attention and interest. It is only natural then that one who has labored zealously in this work would finally compile in a concise volume a discussion of the numerous aspects involved.

The chapter on physics and physiology merits especial attention. Here the author injects originality of opinion and correlates it with the accepted theories on the subject.

In a later chapter the pathology and theory of treatment is described. This may not be in agreement with the theories expounded by others, but the concentrated experience of the author justifies the expression of his viewpoint which seems rational and practical.

Such phases as technic, film interpretion and the roentgenological aspects in general are emphasized and discussed at length. They bear a significant relationship to this work, and, therefore call for the detail which they have been accorded.

While there still exists in the minds of some a certain doubt concerning the practicability of the displacement method, its acceptance by the majority of laryngologists is the criterion. This volume serves admirably for the novice as well as for the experienced. It is suitable for reference as well as for full direction and should be received with satisfaction by those whose scientific interest in this newer field has kept apace with modern advances in the specialty. The text material easily demonstrates a determined effort on the part of the author to present a substantial and informative treatise on the displacement method of sinus diagnosis and treatment.

1932 ANNUALOG. Edited by *Louis S. Treadwell,* Associate Editor, *Scientific American.* Vol. VII. Pp. 248 with illustrations. Cloth. Price $1.50. New York: Scientific American Publishing Company. 1931.

The 1932 Annualog like its predecessors is a compilation of some of the interesting facts and scientific contributions of a worthwhile nature that have passed through such critical evaluation as to deem them of value for permanent retention. According to the editor, "The main body of the text, however, is the record of the year in Industry and Science and to render this in readable accumulated form special articles are presented — these being edited with all possible care to preserve accuracy and news value."

The book is a digest of probably as interesting and varied a group of selected readings as is to be found in a single volume. Space would not permit to list the heterogeneous contents of the material here incorporated. One can find interesting subject matter indexed under each letter of the alphabet — from "air navigation" to "x-ray research". Progress in the various branches of science and industry is well represented by many interesting abstracts and short reviews. Medicine and the allied sciences are also here well represented by abstracts of generous lengths. The book is rather panoramic than encyclopedic in nature — and it is so intended. Its reading is highly informative and will be rewarded by the accumulation of knowledge of a useful nature. Even physicians should keep abreast of the progress of our times.

THE DEVELOPMENT OF PHYSIOLOGICAL CHEMISTRY IN THE UNITED STATES. By *Russell H. Chittenden,* Professor of Physiological Chemistry in the Sheffield Scientific School of Yale University, 1882-1922. Pp. 427. Cloth. Price, $6.00. New York: The Chemical Catalog Company, Inc. 1930.

The American Chemical Society has been doing a splendid service to science by publishing their technical monographs of which this book is a representative example. In this volume an "attempt has been made to show by explicit statements of actual experimental accomplishments, at different times and different places, by many workers and groups of workers, something of the progress which has been made in this country during the past half century in the field of physiological chemistry . . . as indicated by the character of the work undertaken and by the rapid increase in the numbers of those occupied in research, as well as by the widespread increase of laboratories for instruction and research." The present work is, therefore, informative and historical in character and covers the facts as hinted in the excerpt from the above preface in a masterly fashion. As an historical document it should appeal to all students of medicine. To the specialized student in physiological chemistry this book no doubt will have a particular appeal because of the well selected and critical material herein incorporated. It presents a panoramic picture on a vast scale of the tremendous labors accomplished by the outstanding scientists in this particular field of chemistry. The reader will close this volume with a feeling of profound respect for those men who have toiled in the secluded laboratories of science for the sake of humanity. Chittenden has painted a picture in such simple and inspiring colorings that it leaves no room for criticism. It depicts the idealism of an ever-increasing group of workers in a highly specialized science, their pioneer efforts and their successes. The history of the development of physiological chemistry in the United States has been here described in such vivid detail that it fairly challenges in interest the best of romances. This book should be in the hands of not only the student of science but should be read by the entire medical profession.

RHEUMAPROBLEME. Vol. II. Collected addresses for physicians from the Institute of Rheumatic Investigations at Landesbad of Rheinprovinz in Aachen (October 23-25), 1931. By Prof. Dr. *Assmann,* Leipzig; Prof. Dr. *Bieling,* Frankfurt a.M. Höchst,; Prof. Dr. *Boehm,* München; Prof. Dr. *Bruhn,* Düsseldorf; Prof. Dr. *Eckstein,* Düsseldorf Oberarzt; Dr. *Fischer,* Aachen. Oberarzt; Dr. *Gehlen,* Aachen; Prof. Dr. *Graff,* Hamburg, Chefarzt; Dr. *Krebs,* Aachen; Prof. Dr. *Külbs,* Köln; Dr. *Loewe,* Vertrauenszahnarzt der Landesversicherungsanstalt Scheesien, Breslau; Prof. Dr. *Manteufel,* Düsseldorf; Prof. Dr. *Müller,* Konigsberg i.; Prof. Dr. *Strauss,* Berlin; Prof. Dr. *Thannhauser,* Freiburg, i. Br. Pp. 152 with 72 illustrations. Paper. Price, M.12.

The second volume like its predecessor is made up from the collected addresses presented for physicians interested in the various phases of rheumatism, delivered at the Institute of Landesbad in the Rheinprovinz, at Aachen, October 23-25, 1930. The volume is divided into 15 chapters, each chapter consisting of an address on one of the many related problems in rheumatism. It thus presents a fairly comprehensive summary of the present day concepts on this difficult problem in Germany. Some of the topics herein discussed are the pathogenesis of chronic affections of long bones; experimental demonstration of chronic infective arthritis; interpretation of roentgen pictures in arthritis; the causative and focal factors in relation to rheumatic disease; dental and stomatological factors as related to arthritis; heart in relation to chronic rheumatism; endocrine disturbances in arthritis, etc. The book is a timely contribution to a subject that has engaged the attention of our best minds in medicine. The rheumatic problem has challenged the best efforts of the profession, and any contribution that offers some suggestions for its amelioration is generally read with extreme interest. The publishers are again to be highly commended for the excellency of the physical make-up of this as also of the first volume of this work. The technical artistry of their publications have on more than one occasion been favorably commented upon by the reviewer. The present volume is highly recommended.

INTERNATIONAL ABSTRACTS

Pelvic Diathermy. Geo. Gellhorn.

Amer. Jr. of Obstet. and Gynec. **22:**297 (Aug.) 1931.

Pelvic inflammations are treated by using a block tin indifferent electrode around the waist and an active Chapman vaginal electrode which snugly surrounds the cervix and completely fill the fornices. The author thus using "internal diathermy" vaginally demonstrates that heat is readily dispersed into the pelvic organs as shown by thermometer readings in the bladder and rectum. The active hyperemia thus induced is beneficial indirectly by locally increasing the number of leucocytes and antibodies. Pressure on nerves by venous stasis is also reduced with subsequent prompt relief from pain. The author warns that the treatment should be judicious and that the physician must be well aware of the underlying pelvic pathology and points out certain clinical conditions as extopic pregnancy or fibroids, may be readily aggravated. With this form of therapy operations for pelvic inflammatory conditions may be obviated or rendered more simple when following a course of pelvic diathermy.

Re-radiations in the Radium Therapy of Carcinoma of the Cervix Uteri. G. G. Ward and Lilian K. P. Farrar.

Amer. Jr. of Obstet. and Gynec. **22:**543 (Oct.) 1931.

The authors have, wherever possible, personally followed their irradiated cancer cases every month for a period of five years. They find that subjective symptoms are unreliable and that incipient local recurrence can best be detected by an examination of the patient. Thus in 170 cases of epidermoid and adenocarcinoma of the cervix nearly 50 per cent were re-radiated, and of this latter group, 26.5 per cent survived the recurrences for five or more years. Some of these were re-radiated as much as five times. Radio-resistance of the cancer will not develop if large, prolonged and frequent dosages are avoided.

Cancer of the Tongue. Julian B. Smith.

Austr. and N. Zeal. Jour. Surg. **1:**202 (Sept.) 1931.

1. The surgery of the primary lesion has given way to radium treatment. In massive cases diathermic reduction of size is followed by radium implantation.

2. The lymphatic area is the real problem; classification into hopeful and hopeless cases is useful: (*a*) Highly sensitive types may be treated by deep therapy or collar alone. (*b*) But all good conditioned subjects of early adult type of lesion should have a Crile operation followed by radium collar. (*c*) Advanced cases may be treated palliatively so long as suffering is not greatly added to.

3. The writer has no five-year series to report, but sees promise of a far better five-year survival rate than that of the pure surgical *régime*.

4. The treatment that offers as part of its course a devastating Crile operation calls for improvement and meanwhile we await a good supply of highly selective monochromatic rays or an antidote to the specific growth-promoting substance. — *Author's Summary.*

A Five to Fifteen Year Follow-up Study of One Hundred and Ninety-two Cervical Cancers. Frank W. Lynch.

Amer. Jr. of Obstet. and Gynec. **22:**550 (Oct.) 1931.

Lynch has analyzed his cases which were classified in the usual five clinical groups (Schmitz classification). The cases treated by modified Ries operation and radium insertion or radium only are thus analyzed from the standpoint of possible "cures".

Treatment of Superficial Fungus Infections with the Long Wavelength Roentgen Rays (Grenz Rays). Maurice Dorne and Cleveland White.

Arch. Derm. and Syph., **24:**409 (September), 1931.

This study was pursued for the purpose of evaluating the therapeutic possibilities of the so-called grenz rays.

Forty patients were treated, but this report involves only thirty, ten having disappeared from observation. Early in the investigation, the clinical diagnosis of superficial fungus infection was considered sufficient indication for this type of therapy, and the first patient treated showed a marked improvement within a week after the first treatment was given. The next three patients showed no improvement whatever, even after three treatments. A complete check-up of apparatus at this time revealed the fact that the machine was functioning properly. It was apparent to the authors that they were facing the same problem that they had encountered with the other forms of treatment, namely, the refractiveness of these fungus infections to treatment. At this point it was decided on the routine smears (potassium hydroxide) and cultures (Sabouraud's dextrose mediums) in every case presented for treatment. As a result of this routine examination it was soon learned that the cases that were positive for Monilia and yeast-like fungi responded most rapidly, and in almost every instance of this particular variety good results were obtained.

An attempt has been made to evaluate the so-

caleld grenz ray in the treatment of superficial fungus infections of the skin. By the use of fractional doses good results were obtained in the patients who had infections due to yeastlike fungi, while the infectious of hyphomycetic origin showed very little if any improvement.

It is realized that this series is only sufficiently large to give suggestive, not conclusive, results. The investigation is being continued.

Ultraviolet Radiation — What, Why and How. George E. Crosley.

Phys. Therap., **49**:201 (May), 1931.

Ultraviolet radiation of practical therapeutic interest is found in that part of the spectrum between 1700 and 3200 ångström units and in none other.

There are three principal therapeutic effects of ultraviolet radiation in this region — direct germicidal, benign inflammatory reaction, and vitamin-D production through action on ergosterol.

As there is marked variation in the amount of therapeutic ultraviolet in sunlight, just so is there variation in the amount of vitamin-D found in butter and eggs.

Retention of calcium and phosphorus depends upon three factors — sufficient calcium in the diet, sufficient prosphorus in the diet, sufficient vitamin-D to act as a catalyst and permit the utilization of calcium and phosphorus.

Deficiency of calcium and phosphorus causes rickets, spasmophilia, osteomalacia, and tetany.

Deficiency of calcium and phosphorus predisposes to hemorrhage due to increased clotting time.

Deficiency of calcium and phosphorus predisposes to catarrhal conditions, increased anaphylactic reactions, increased muscular and nervous irritability, increased acidosis, infections, disturbances of the digestive tract, mental depression, and susceptibility to disease.

Available evidence indicates that the natural avenue of absorption of vitamin-D is through the skin from activated ergosterol rather than through the digestive tract. Note the Iceland-Faroe Island investigation, the lowered vitamin-D in animals eating sun irradiated food as compared with increase in vitamin-D when animals are exposed to ultraviolet radiations from summer sun or artificial sources, and the absence of hypercalcemia from irradiation while produced from over-feeding with vitamin-D.

The sun is not the ideal and during the colder months is entirely impractical as a source of visible, infrared, or ultraviolet radiation adequate for therapeutic use. Dependence must be upon artificial sources.

Radiations from a carbon arc do not closely approximate those from the sun.

The ideal source of any band of radiation is that source which will give the greatest volume in the region desired, taking into consideration the matters of safety, convenience, sanitation, economy, and scientific accuracy of control of output.

The ultraviolet radiations practically effective in preservation of health and cure of disease are found in the narrow band between 1700 and 3200 ångström units and in none other.

There is no evidence to prove that they are more or less effective whether occurring as a so-called "line" or "continuous" spectrum.

The physician desiring to use ultraviolet in his work will choose that source which will give the greatest volume of radiation in the region 1700 to 3200 ångström units, taking into consideration the following factors — sanitation, convenience of operation, safety as to fire hazards, economy as to operating costs — because in lamps as in other apparatus, it's not the first cost but the upkeep that counts, and last but of prime importance, accurate scientific control of input of current and output of ultraviolet so that dosage may be accurately prescribed and administered.—Author's Summary.

Immediate and Delayed Effects of Radium (Gamma Rays) on Tissue Cultures in Vitro. F. G. Spear.

Brit. Jour. Rad., **4**:146 (April), 1931.

Gamma radiation has a definite effect in reducing the number of cells in mitosis in tissue cultures *in vitro*. This effect is not demonstrable until the culture has been subjected to a given irradiation for a definite period of time. When this threshold is passed the effect is well marked. The maximum diminution in mitosis is seen about 80 minutes after irradiation is completed. There is no evidence of true stimulation of mitosis under the experimental conditions used in the present work.

Gamma radiation is capable of causing a delayed lethal effect on tissue cultures *in vitro*, the period of survival before death depending on the "dose" of radiation to which the cultures are exposed.

In each case when the quantity of radium is constant, increase of exposure produces increased effect. When two different quantities of radium are used, and the results of exposure compared, the effect on mitosis is more marked with the larger quantity, even when the duration of irradiation is reduced in proportion to the greater mass of radium. The same result is seen in the delayed lethal effect: exposure to the larger quantity of radium reduces the survival period more effectively than exposure to the lesser quantity of radium for a correspondingly increased period.

These effects must be attributed to a direct action of the gamma rays upon the cell, and it seems reasonable to suppose that cells *in vivo*, irradiated under similar conditions, will be subjected to similar influences. The result of irradiation may, of course, be modified—possibly very considerably modified—by the altered environment of the cell *in vivo* as compared with conditions *in vitro*, but it seems justifiable to assign any difference in the effect observed to the reaction of the organism as a whole, and not to any fundamental change in the character of the cell when examined *in vitro*.

This seems to be supported by the work of Strangeways and Fell (1927) on the direct and indirect effects of x-rays on fowl embryos. The results showed that irradiation blocked the blood vessels with clotted blood; tissues from such embryos, if removed from the body 80 minutes after irradiation, recovered when cultivated *in vitro*, but if left *in ovo* for another 24 hours they became completely

necrotic. On the other hand, if embryos in which the circulation had not been established were irradiated, partial recovery took place *in ovo* after 24 hours' incubation subsequent to irradiation.

Mottram (1927) points out that, whereas there are wide differences in the sensitivity of different tumors *in vivo* to irradiation, the lethal dose *in vitro* is found to vary very little. He suggests the hypothesis that the varying sensitivity of tumors to radiation, and the difference in sensitivity between normal tissues and tumors is associated with variations in blood supply on which radiation has a special action apart from its direct action on cells.

Laser and Halberstaedter (1929), studying the retardation of growth in tissue cultures after irradiation, concluded that the factor determining radiosensitivity both for normal and malignant cells was rate of proliferation of the cells in the culture.—*Author's Summary.*

Zinc Ionization in the Treatment of Rhinitis and Nasal Accessory Sinusitis. Carl B. Sputh, M.D.

J. Indiana M. A. **24**:461, (Sept.) 1931.

Zinc ionization for the treatment of catarrhal sinusitis in children has given splendid results. After one treatment the child is relieved of the constant nasal discharge, hacking or spitting, nasal respiration is improved, sleep is sound instead of restless and there is a marked change in the youngster's physical and mental make-up.

The author has made no scientific investigation, but from clinical observations he is convinced that through ionization the medication is carried into the sinuses as evidenced by the results he has achieved.

Treatment: The treatment is divided into two parts, namely: (1) General. (2) Local. General treatment, which is administered by the general practitioner, should include proper measures for any constitutional disorder which may exist and the regular diet and hygiene.

The local treatment consists of eradicating and correcting any predisposing intranasal deformities and obstructions. After this is done, some type of treatment should be given which will restore the tissues to their normal state. To bring this about I have used zinc ionization during the past two years, and I am happy to state that it has given me by far the best results of any type of treatment that I have used heretofore.

The technique is as follows:

1. Cleanse the nostril thoroughly, removing all mucus, crusts, etc.
2. Swab with a four per cent cocaine solution two or three times.
3. Pack the nostril with strips of gauze saturated in zinc sulphate solution (one-fourth to one per cent) leaving enough space at the bottom to permit the insertion of a zinc needle which is wrapped in cotton and saturated with the solution.
4. Attach the positive galvanic terminal to this needle. Apply the negative terminal to a sponge soaked in normal salt solution which is placed at the base of neck.
5. Turn the current on slowly to about ten M. A., if the patient can tolerate it, and run for ten minutes. Then turn the current off slowly.
6. Remove the packing.

CONCLUSIONS

1. Zinc ionization, a non-surgical procedure in the office, is of unusual benefit in selected cases.
2. Intumescent and hypertrophic rhinitis lend themselves admirably to zinc ionization.
3. Zinc ionization is a valuable added means in the treatment of the nasal accessory sinuses.
4. Following intranasal surgery, zinc ionization is an ideal method of restoring the nasal tissues to normalcy.

Carcinoma of the Esophagus: Esophagoscopic Observations on Diagnosis and Treatment. Chevalier Jackson, M.D.

Ann. Otol. Rhinol. and Laryng. **40**:886, (Sept.) 1931.

The author's conclusions are:

1. Most patients with cancer of the esophagus are treated under an erroneous diagnosis of "spasm" until the growth is far advanced.
2. Esophagoscopy is the only means of making with certainty a very early diagnosis of cancer of the esophagus.
3. Roentgen ray study is a most valuable means of diagnosis of malignant disease of the esophagus.
4. Neither esophagoscopy nor roentgen ray study should be omitted in any case of the slightest abnormality in swallowing; both are essential for diagnosis.
5. A diagnosis of spasm of the esophagus should never be regarded as more than tentative until an organic lesion has been ruled out by esophagoscopy.
6. The operation of esophagectomy has never had a fair trial because the esophagoscopist and the roentgenologist very rarely have an opportunity to make an early diagnosis. The surgeon should be encouraged in his efforts to perfect the technic of operation and also that of external implantation of radons in cancer of the esophagus, cervical, thoracic and abdominal.
7. Deep roentgen ray therapy is the most efficient of the palliative measures directed against the growth itself; but only when instituted early and combined with proper medical care and management, especially dietary management. It is a mistake to radiate a patient far advanced in emaciation and cachexia. Increase of toxemia will shorten his days.
8. Radium and radons in our hands have been, on the whole, less effective than deep roentgen ray therapy; but their use is advisable in some cases.
9. Earliness in commencing palliative treatment is quite as essential as in any attempt at cure. The difference in prolongation of life between palliative measures begun very early and those instituted late usually amounts to many months, sometimes years.
10. Gastrostomy, intubation and esophagoscopic dilatation all have advantages and disadvantages, but each and all require early performance to yield satisfactory results. This requires early diagnosis, which is rarely done, for lack of early esophagoscopy.

11. The choice as among gastrostomy, intubation and dilatation should be left to the patient after the situation is explained to him. He who sets great store by the pleasures of the table will prefer to have swallowing maintained to the last at all hazards. Those who have a life's work to finish and consider time at table wasted will prefer utmost prolongation of life with least possible risk in the means employed.

12. One of the most essential elements in palliation is the very early institution of medical care and management, especially as to diet. Loss of weight and vitality are easier retained than regained. Vegetables and raw fruits must form a large part of the daily dietary. They must be properly sieved to prevent them lodging; lodgment causes esophagitis and increased stenosis. Any food that will go through a mesh of 25 to the inch will pass through a very small lumen. cancerous or tubal. Milk should never be given within three hours of curd-producing foods. Small cancerous fistulæ are more often clogged with curds than with anything else.

Carcinoma of the Larynx — Its Treatment by Diathermy. Harrington B. Graham, M.D.

Cal. and Western Med. **35**:375, (Nov.) 1931.

Harrington's attention was called to the value of diathermy in carcinoma of the larynx because of the success achieved in its use in a nonlaryngeal malignant growth, one involving the left tonsil with loss of the uvula and a part of the soft palate. Diathermy and radium were applied some fifteen years ago with entire success, the patient being alive at the present time.

Part of the author's report follows:

"Succeeding this I used diathermy in a case of cancer of the vocal cord in a lawyer, after removing as much of the growth as possible by a double curette. This was all done by the direct method, per oram, under general anesthesia. At the time the whole vocal cord appeared to have been removed. Three months after the operation the patient appeared in the office with a normal voice and vocal cord and stated that he was carrying on his work in court with perfect ease. He died two years later of pneumonia, but up to the time of his death there had been no recurrence.

"It is quite possible to apply the diathermy to any part of the larynx by the indirect method under local anesthesia, in this way producing a coagulation which is sufficient to destroy any small carcinoma in the early stages without destroying the function of the larynx or taking the chance of distribution of cancer cells by laryngofissure, as Mackenzie advocated at the Copenhagen Congress. In case the infiltration is more extensive, involving the cartilaginous wall, I doubt if fulguration is sufficient. Here a laryngo-fissure would not help, laryngectomy alone being indicated.

"It seems to me, therefore, that diathermy is the method of choice in all cases of early cancer of the larynx when close inspection is not necessary. There is no objection to applying the diathermy under general anesthetic, even under ether, if the precaution is taken to allow the patient to take several breaths before turning on the current so as not to cause an explosion of the ether. In case a bronchoscope is used, the needle should be well covered with rubber to the tip, only a small portion being exposed and the needle being introduced well beyond the end of the scope.

"In inoperable cases, with the growth practically occluding the passage, I have found diathermy of especial value. In these cases an extensive coagulation may be carried on with deep penetration of the needle into the tissues under local anesthesia and morphin. The amount of destruction that takes place frees the larynx of the obstruction, gives the patient air without a tracheotomy and eventually may produce a scar tissue which relieves the situation for years. There may be pain subsequent to the operation which may be controlled for a few days by morphin, but some of the patients do not complain at all.

"This, in my hands, has been a much more humane method than an attempted laryngectomy with all its attendant unpleasant sequelae, and the lack of a tracheotomy tube is much appreciated by the patients. It is a simple matter to do this work; a repetition is just as simple and the patient may be carried over a terrible period in his life when breathing is generally extremely difficult and communication just as annoying. It is astonishing how much room may be obtained in a couple of days when only one side of the larynx is treated in this way, decreasing the pain and limiting the difficulty in swallowing."

Physicotherapy of Hypertonia. Prof. A. Strasser, Vienna. (Report of Annual Meeting of Austrian Balneological Association).

Zeitsch. f. Physikal. Therap. **40**:6, 1931.

Partial baths with a gradual increase of the temperature according to *Schweninger* and *Hauffe* have a very favorable effect. The legs or forearms are placed in water at a temperature of 96° F. to 98° F. which is gradually raised to 114—116° F. by the addition of hot water. The bath should last about 20 minutes until there is a slight outbreak of sweat. The effect is pleasant and relieves the heart though it does not usually last long. It is explained by *O. Müller's* law of consensual reaction, according to which a procedure affecting one part of the skin affects the whole organ of the skin and by *Dastre-Morat's* law, according to which a vasodilator effect takes place also in the other parts of the peripheral circulation (transversely striated muscles, large glands, intestinal blood vessels, thus regions dominated by the splanchnic nerve) analogous to the vasomotor dilatation of the cutaneous vessels. — *Lahmann's* brush baths have a similar but much more extensive effect. The patient, in a bath at a temperature of 94°, is brushed with a rough brush for about 10 minutes until his skin is quite red. — Carbonic acid baths dilate the capillaries and facilitate the heart's action. Their effect depends chiefly on the temperature of the bath. For extremely high blood-pressure, CO_2 baths are unsuitable. — Iodine baths offer better prospects in arteriosclerosis then with essential hypertonia. Minute doses of iodine

dilate the fine blood-vessels and reduce the viscosity of the blood. — With plethoric hypertonia the water of alkaline-salinic springs is indicated. — Radium baths may produce successful results with any kind of hypertonia. They affect the splanchnic nervous system and their effect is further due to electrolytes displacement. — The successful results of sulphur and Vaccineurin injections, perhaps also those of brine baths, are of the nature of non-specific protein therapy. — Physicotherapy may be effectually reinforced by medicinal treatment; it is well to remember that theobromine preparations are more suitable for arteriosclerotic and nephrogenous forms, whereas medicaments which affect the midbrain (Luminal etc.) are rather indicated in the essential forms. — *Ars. Medici,* October, 1931.

Rectal Carcinoma — Cold Cautery. Prof. Kirschner, Director of the Surg. Clinic, Tübingen.

Münch. med. Wochensch. **28,** 1931.

In the author's opinion, electrocoagulation represents a decided advance in the technique of operation. Two methods can be distinguished: 1. Wholesale coagulation of large tumors, which offers prospects of permanent results even in cases which have, so far, been regarded as inoperable. 2. Electric severance (»melting cut«) used in cases that can still be treated by radical operation; this method makes it possible to prepare the tissues automatically almost without loss of blood provided that large blood-vessels are avoided. This means a saving of blood and strength, a better survey and thoroughness of extirpation. All the blood-vessels which are noticeably severed must, however, be ligatured according to rule in order to prevent the risk of secondary hemorrhage. Carcinoma germs near the incision line should be coagulated. It is striking how little the general condition is affected after operation; evidently because all the blood and lymphatic vessels that have been severed are immediately closed by coagulation so that the flooding of the organism with bacteria and toxins (and a proportion of carcinomatous germs — Reviewer) is avoided.

A carcinoma which would have been inoperable by the methods used hitherto is exposed, generally with extensive division of the posterior wall of the rectum, the diseased masses are planed off as radically as possible with the electric snare, and the remaining parts of the tumor burnt into the depth with a mass electrode. In this way, astonishing individual results have been achieved which, it is true, should not yet be generalized. — *Ars. Medici,* October 1931.

Therapy of the Colon. Lynn J. Walker.

Am. Jour. Phys. Ther., **8**:8 (April), 1931.

The writer from his personal experiences has definitely concluded that a restoration of the chemical balance of the eliminatory function of the colon should be foremost in the treatment of what appears to be a general toxic condition. In freeing the bowel of its residual content and terminating the flow of the toxins and bacteria into the blood stream, the individual is afforded an opportunity to create a resistance and in effect to cure himself. If this is accompanied by a stimulation and restoration of the tone of the muscle wall of the bowel, a recurrence of the toxic condition is rendered highly improbable.

Care must be exercised in the treatment, first, to obtain and then to maintain the proper cell balance. For this reason, an alkaline solution in the medication of the caecum should not be employed daily, but when a balance is approximated, there should be an alternation of an alkaline and an acid solution. This alternation serves not only to maintain a cell balance, but it is very effective in ridding the bowel of undesirable bacteria, inasmuch as some bacteria thrive in an acid media and others in an alkali media. Some, of course, thrive in both. The colon B and B Welchii both thrive in an alkaline surrounding; in fact solutions such as sodium bicarbonate actually stimulate their growth. It follows, therefore, that the deficiency in the chemical cell balance of the individual must be ascertained and the treatment must be regulated in accordance with the findings.

Although the technique and theory which the writer has herein set forth are by no means a panacea for all ills, they are deserving of a great deal of attention from the medical profession, because of the important diagnostic and therapeutic results that can be achieved and have been achieved through their employment. They are emphatically not tools for the uninitiated, but they are just as emphatically, in the hands of the practiced physician, capable of bringing untold relief and terminating immeasurable suffering.—Author's Summary.

Changes in Sugar and Lactic Acid Content of Blood Caused by Burns. M. A. Slocum, and H. D. Lightbody.

Am. J. Physiol., **96**:35. 1931.

Studies have been made of the concentration of sugar and lactic acid in the blood of rabbits, burned with the suprarenal glands intact, and after the removal of the glands. The concentrations of both sugar and lactic acid were found to be increased. The increase of lactic acid was small and does not appear to account for the high sugar values. Twenty-four hours after burning, animals with the intact glands were found to have maintained the increased blood sugar while the lactic acid concentrations were reduced below the initial values. The studies indicate that increased activity of the suprarenals do not account for the increased blood sugar through lactic acid as an intermediate, or by a decreased rate of oxidation of the sugar.—Author's Summary.

Effects of Diathermy of the Thyroid on the Basal Metabolism. (Influence de la diathermie de la glande thyroide sur le metabolisme basal). J. Jankowski and L. Ptaszek.

Compt. rend. Soc. de biol., **103**:425. 1930.

Diathermy produces a temporary fall in basal metabolism followed by a return to the former level. When such a fall has been initiated, further treatment is ineffective until the usual metabolic level has been re-established. Repeated treatments become less and less effective.

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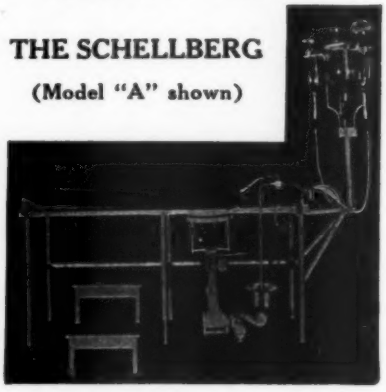

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TOUR No. 1 lands at Havre, early Saturday, July 23rd. At Havre there will be no customs formalities for members of the group.

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Sunday, July 24th and Monday, July 25th, will be spent in Paris. Leaving Paris on Tuesday, July 26th, the party will proceed by special train with wagon restaurant car and baggage car for Strasbourg. A special train will be at the disposal of the group throughout the entire trip. The travelling will be done entirely by daylight and meals will be served en route.

Between July 26th and August 20th the following Cities, Spas and Watering Resorts will be visited: Strasbourg, Contrexeville, Vittel, Evian-les-Bains, Aix-les-Bains, Avignon, Nice, Grande Corniche, La Turbie, Menton, Monte-Carlo, Monaco, Villefranche, Antibes, Juan-les-Pins, Cannes, Marseille, Carcassonne, Luchon, Superbagnères, Biarritz, St. Jean de Luz, Dax, Hossegor, Vichy, Paris. On Saturday evening, August 20th, the party will arrive in Paris and remain there until Wednesday, August 24th, when departure will be made for Havre, returning to America on the "S. S. Paris."

Each member participating in this trip is required to pay a thousand dollars. This is his total expense. All steamship transportation, hotel expenses, meals, special trains, lectures, theatres, motor trips, etc., are defrayed by the French Government. In short, the entire trip from New York and return represents a personal outlay of one thousand dollars per person..

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NOTICE CONCERNING TOUR No. 1 and TOUR No. 2

First class accommodations will be provided, with the entire party always at the same hotel. In the Cities where Spas are visited, an official reception, banquets, a lecture by a professor of medicine, evenings at the theatre, automobile trips in the neighborhood, etc., will be held.

The accommodations, meals, automobiles, luggage and other details connected with the trip, will be arranged and carried out by a representative of the French Government. The physicians may, if they desire, be accompanied by their families.

Members of the delegations wishing to remain in France for a longer period than the official trip can do so and will be free to choose the steamer most convenient to them, but must be one of the French Line.

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